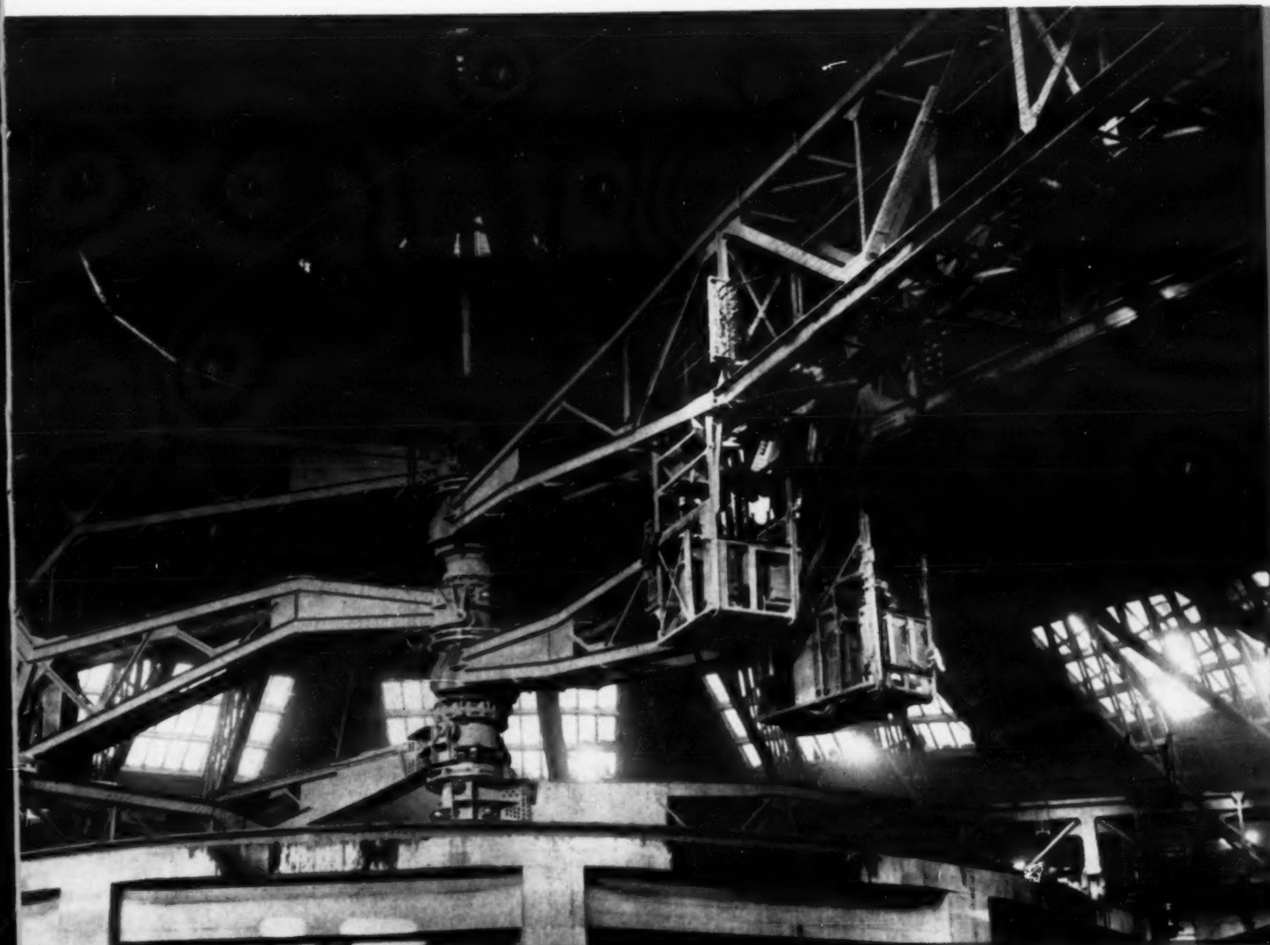
modern castings

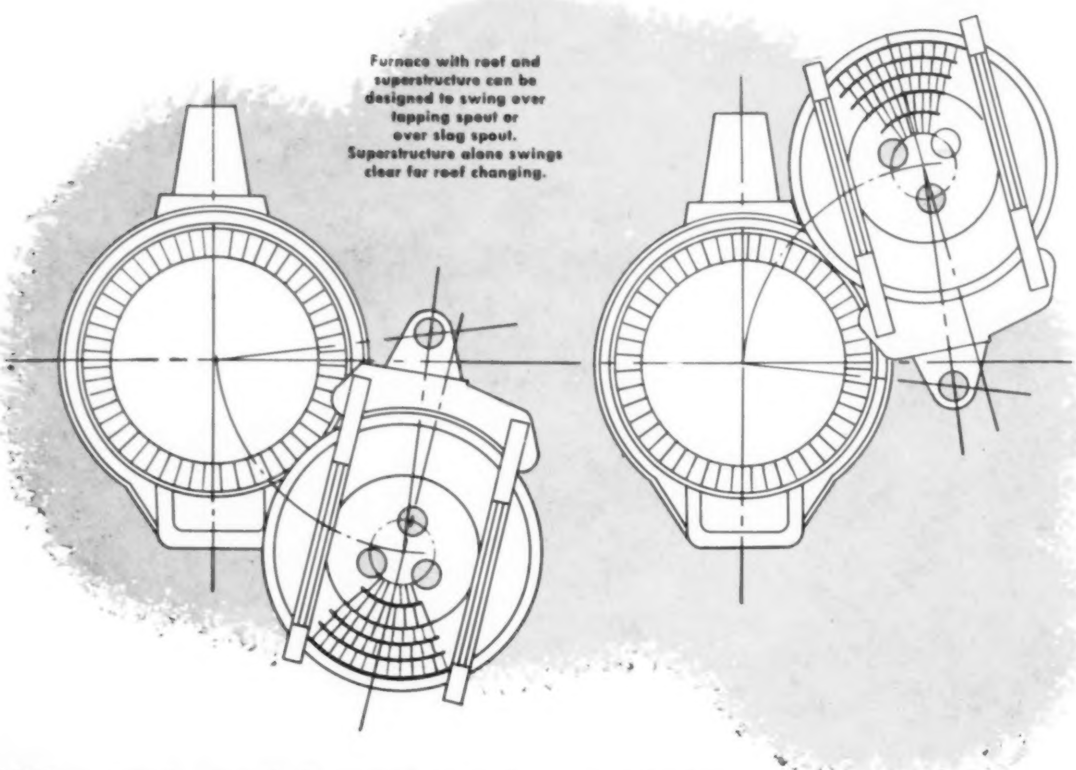
September 1958

The Foundrymen's Own Magazine



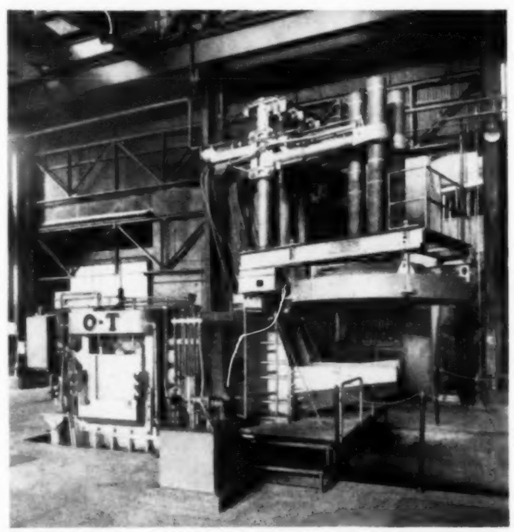
Foundry in the Round

Six electric traveling cranes are mounted independently, one above the other, in the 300 ft diameter iron foundry of Burmeister & Wain's, Tegleholmen, Denmark. The three 30 ton cranes and three 10 ton cranes pivot on a steel mast in center of main foundry bay. A two story concrete building in middle of circular foundry houses offices and storage.



With a Lectromelt Furnace you have a choice

THE ROOF CAN BE BUILT FOR FRONT OR BACK SWING



SELECT the direction of swing that best fits your plant layout—over the tapping spout or over the slag spout. Lectromelt's design and method of separately supporting the roof structure makes this possible. You profit by the greater efficiency and convenience that result.

Note in the above drawing how the furnace top swings clear of the furnace; there's no interference with the charging bucket to slow down the charging operation. Lectromelt places the pivot point away from the furnace shell to accomplish this. And, because the swing of the top can be less, there's less strain on the conductors.

Catalog No. 10 describes Lectromelt furnaces. For a copy write Lectromelt Furnace Division, McGraw-Edison Company, 316 32nd Street, Pittsburgh 30, Pennsylvania.

Lectromelt®

McGRAW EDISON

CANADA: Canefco Limited, Toronto . . . ARGENTINA: Master Argentina, Buenos Aires . . . ITALY: Forni Stein, Genova . . . ENGLAND: Electric Furnace Co., Ltd., Weybridge . . . GERMANY: Demag-Elektrometallurgie, GmbH, Duisburg . . . SPAIN: General Electrica Espanola, Bilbao . . . FRANCE: Stein et Roubaix, Paris . . . BELGIUM: S. A. Stein & Roubaix, Bressoux-Liege . . . JAPAN: Daido Steel Company, Ltd., Nagoya

Circle No. 801, Page 7-8

future meetings and exhibits

SEPTEMBER

4-5 . . American Society of Mechanical Engineers. *International Conference on Air Pollution*. Statler Hotel, New York.

7-12 . . American Chemical Society, *Fall Meeting*. Chicago.

10-11 . . American Die Casting Institute, *Annual Meeting*. Edgewater Beach Hotel, Chicago.

15-19 . . Instrument Society of America, *Instrument-Automation Conference & Exhibit*. Convention Hall, Philadelphia.

22-23 . . Steel Founders' Society of America, *Fall Meeting*. The Homestead, Hot Springs, Va.

22-24 . . Material Handling Institute, *Joint Industry Fall Meeting*. The Greenbrier, White Sulphur Springs, W. Va.

23 . . Metallurgical Associates, Inc., *Sales Clinic*. Hotel Sheraton, Boston.

23-26 . . Association of Iron and Steel Engineers, *Exposition*. Public Auditorium, Cleveland.

28-Oct. 2 . . Electrochemical Society, *114th Meeting*. Chateau Laurier, Ottawa, Canada.

29-Oct. 3 . . Association Technique de Fonderie de Belgique, *25th International Foundry Congress*. Brussels and Liege, Belgium.

OCTOBER

6-8 . . National Association of Corrosion Engineers, *Annual Meeting, Northeast Regional Division*. Somerset Hotel, Boston.

8-10 . . Gray Iron Founders' Society, *Annual Meeting*. Sheraton Park Hotel, Washington, D. C.

13-18 . . National Industrial Sand Association, *Semi-annual Meeting*. The Greenbrier, White Sulphur Springs, W. Va.

15-16 . . AFS *Michigan Regional Foundry Conference*. University of Michigan, Ann Arbor, Mich.

16-17 . . AFS *All Canadian Regional Foundry Conference*. Royal Connaught Hotel, Hamilton, Ont.

16-18 . . Foundry Equipment Manufacturers' Association, *Annual Meeting*. The Greenbrier, White Sulphur Springs, W. Va.

17-18 . . AFS *New England Regional Foundry Conference*. Massachusetts Institute of Technology, Cambridge, Mass.

18-21 . . Conveyor Equipment Manufacturers Association, *Annual Meeting*. The Greenbrier, White Sulphur Springs, W. Va.

20-24 . . National Safety Council, *46th National Safety Congress,* Conrad Hilton Hotel, Chicago.

20-24 . . National Association of Corrosion Engineers, South Central Region, *Conference & Exhibition.* Roosevelt Hotel, New Orleans.

22-23 . . National Management Association, Annual Meeting. Statler-Hilton Hotel, Los Angeles.

27-30 . . Metallurgical Society of American Institute of Mining, Metallurgical & Petroleum Engineers, *Fall Meeting.* Carter Hotel, Cleveland.

27-31 . . American Society for Metals, *National Metals Exposition & Congress.* Public Auditorium, Cleveland.

30-31 . . AFS *Purdue Metal Castings Conference.* Purdue University, West Lafayette, Ind.

31-Nov. 1 . . AFS *Northwest Regional Foundry Conference.* Multnomah Hotel, Portland, Ore.

NOVEMBER

10-12 . . Steel Founders' Society of America, *13th Technical & Operating Conference.* Carter Hotel, Cleveland.

20-21 . . National Foundry Association, *Annual Meeting.* Drake Hotel, Chicago.

DECEMBER

3 . . Foundry Facings Manufacturers Association, *Annual Meeting.* Waldorf-Astoria Hotel, New York.

3-5 . . American Institute of Mining, Metallurgical & Petroleum Engineers, *Electric Furnace Steel Conference.* Statler Hotel, Detroit.

3-5 . . National Association of Manufacturers, *Annual Meeting.* Waldorf-Astoria Hotel, New York.

9 . . Material Handling Institute, *Annual Meeting.* New York.

1959

FEBRUARY

12-13 . . AFS Wisconsin *Regional Foundry Conference,* Schroeder Hotel, Milwaukee.

26-27 . . AFS *Southeastern Regional Foundry Conference.* Hotel Tutwiler, Birmingham, Ala.

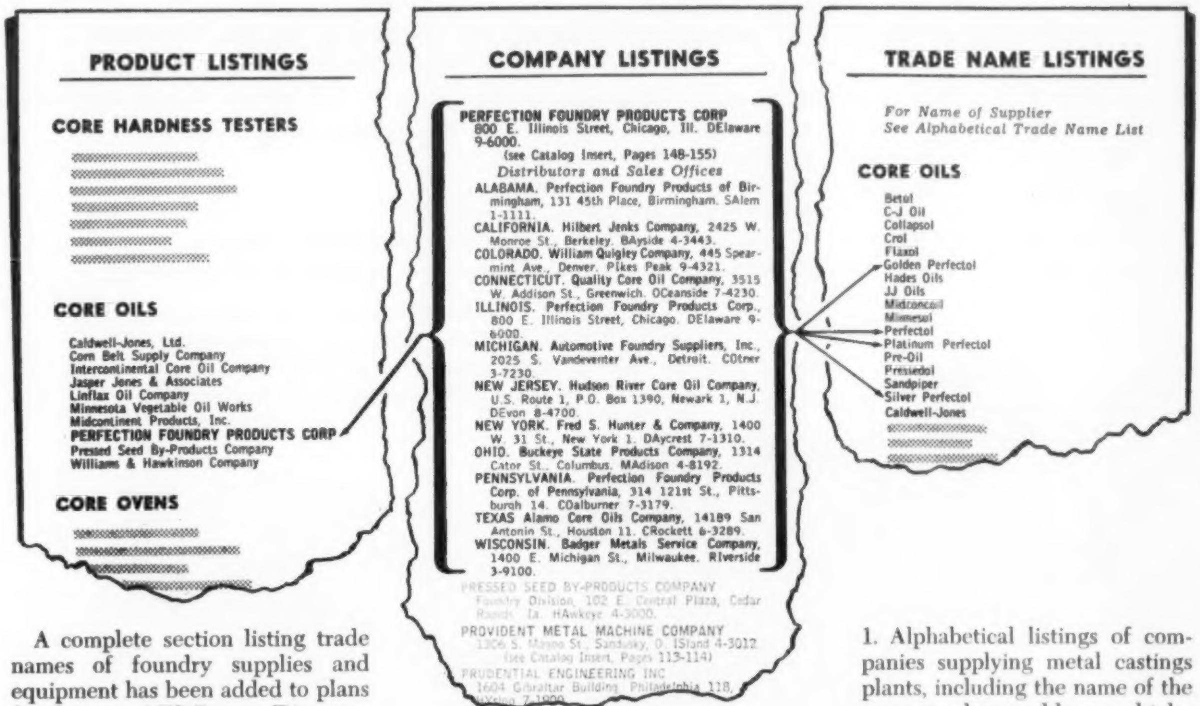
MARCH

13-14 . . AFS *California Regional Foundry Conference.* Huntington Hotel, Pasadena, Calif.

APRIL

13-17 . . AFS *2d Engineered Castings Show and 63d Annual Castings Congress.* Hotels Sherman and Morrison, Chicago.

AFS BUYERS DIRECTORY TO HAVE SIX SECTIONS



A complete section listing trade names of foundry supplies and equipment has been added to plans for the new AFS Buyers Directory to be published for the first time in September, 1959, according to Curtis Fuller, directory manager.

"In fact, you might say that we are adding two trade name sections to the Directory," Fuller said. "First, we are going to classify all trade names by types of products sold to the metal castings industry. And second, we are going to list them alphabetically and give the name of the manufacturing company. Of course these trade-name listings will be free."

The trade-name sections are part of a series of additions made to the Directory which will provide the first complete catalog of products of all known suppliers to the metal castings industry.

In the past six months several hundred foundries and suppliers have been asked to comment on the preliminary plans for the Directory. As a result of their suggestions, approximately 100 additional product classifications and cross references have been added. It is expected that more than 3000 companies will have their products classified and cross-referenced under 900 product classifications in the Directory. Forms for the Directory listings are now being mailed by the American Foundrymen's Society, Golf and Wolf Roads, Des Plaines, Ill.

"It's easy to understand the enthusiasm with which foundry superintendents and purchasing executives have greeted our plans," Fuller said in discussing the comments AFS has received from its own members.

"There never has been anything like a complete buyers' directory in the field before. Foundry superintendents and purchasing agents have had to build up extensive files of catalogs and data sheets.

"The big commercial catalogs were good for general purposes but were not nearly complete enough for the specialized needs of metal castings plants.

"But now we're putting together in a single reference work every known product of every known supplier—all indexed and cross-indexed and as easy to reach as the length of your arm.

Forthcoming AFS Directory will be organized in six basic sections.

1. Alphabetical listings of companies supplying metal castings plants, including the name of the company, home address and telephone number.
2. Product listings of equipment, supplies, materials and services used by the industry, with the names of the supplying companies indexed and cross-indexed under approximately 900 subject headings.
3. Trade name listings.
4. Regional listings. Supplying companies will have an opportunity to list, beneath the parent company listing, the names, addresses and telephone numbers of their distributors, local or regional dealers, supplying warehouses and the like, arranged alphabetically by state.
5. Advertising-catalog services. To make the Directory of maximum value to both buyers and suppliers, advertisers are being urged to place catalog-insert material in the Directory.
6. Associations and societies in the metal castings industry.

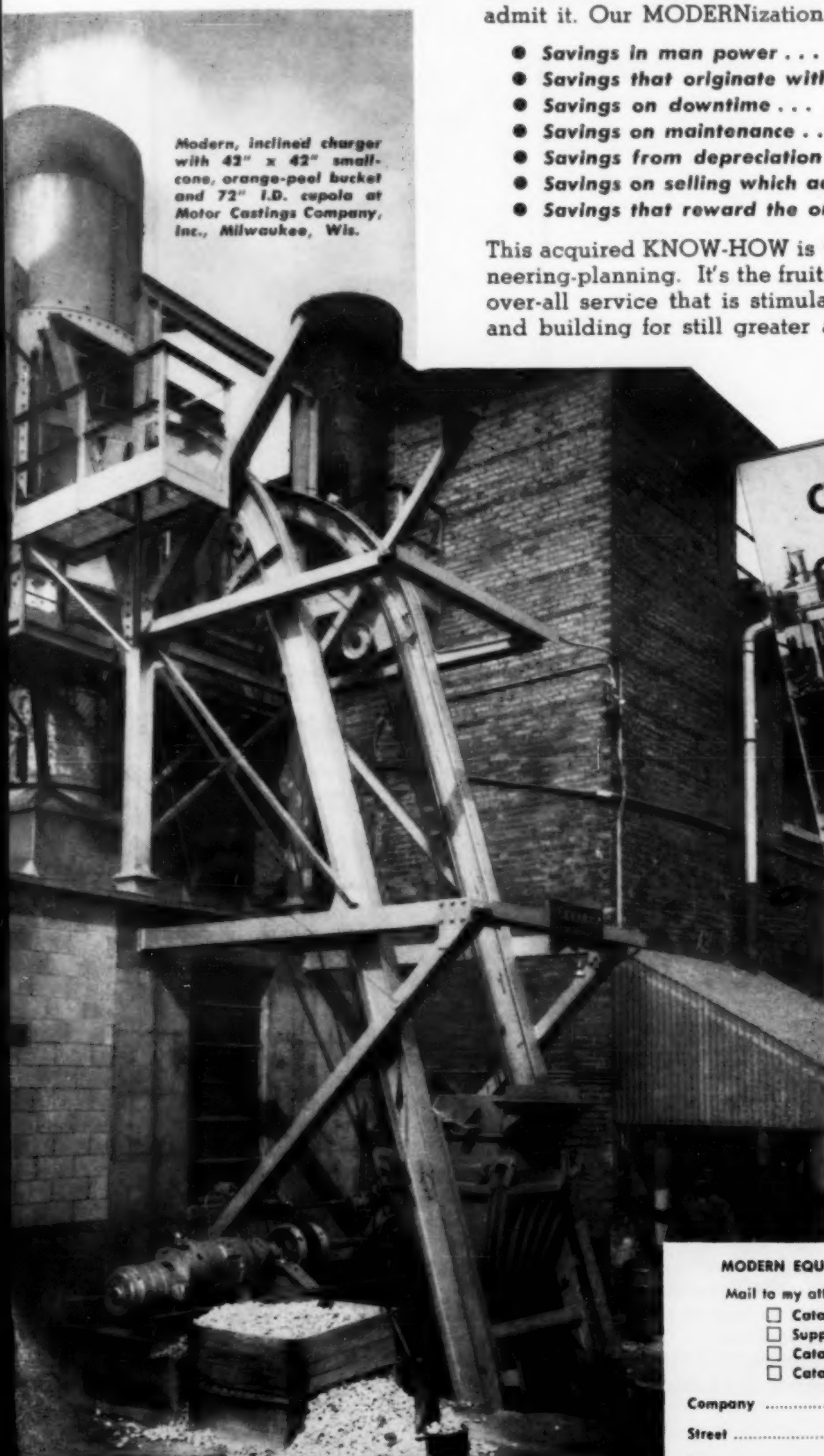
American Foundrymen's Society has agreed to place one free copy of the AFS Buyers Directory in the hands of every foundry superintendent in the United States and Canada.

Paying for Equipment YOU can have !

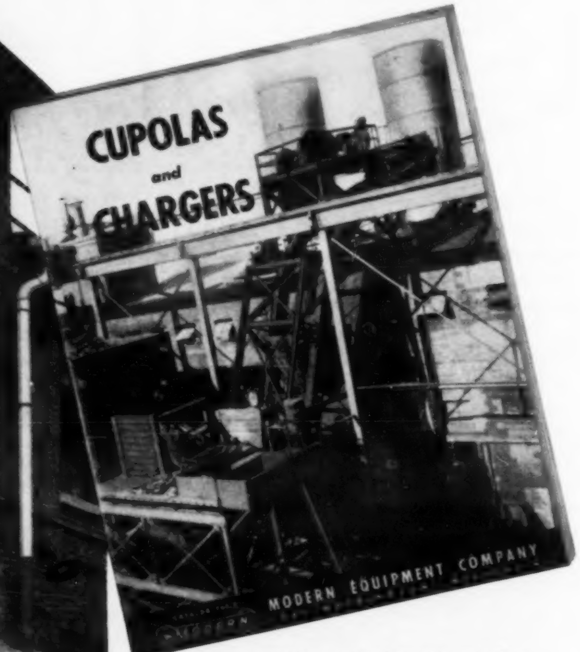
SURE our MODERNization service includes all the preliminaries that go into budget planning! And if we cannot see how YOU can afford to mechanize the MODERN way we shall be first to admit it. Our MODERNization service includes all these factors:

- ***Savings in man power . . .***
- ***Savings that originate with the holding of top technicians . . .***
- ***Savings on downtime . . .***
- ***Savings on maintenance . . .***
- ***Savings from depreciation policies . . .***
- ***Savings on selling which accrue from better castings . . .***
- ***Savings that reward the one-best application of equipment . . .***

This acquired KNOW-HOW is the priceless ingredient in our engineering-planning. It's the fruition of 35 year's experience. It's an over-all service that is stimulating the confidence of new friends and building for still greater achievements for tomorrow.



Modern, inclined charger with 42" x 42" small-cone, orange-peel bucket and 72" I.D. cupola at Motor Castings Company, Inc., Milwaukee, Wis.



Cupola and charger catalog, with water-cooled supplement, will be mailed on your request.

MEMBER FEMA

MODERN

REPRESENTATIVES IN ALL PRINCIPAL CITIES OF THE WORLD

MODERN EQUIPMENT COMPANY, Dept. MC-9, Port Washington, Wisconsin

Mail to my attention:

- ☐ **Catalog 147-C on charging and melting . . .**
- ☐ **Supplement 149-A on water-cooled cupolas . . .**
- ☐ **Catalog 150 on cranes and monorail systems . . .**
- ☐ **Catalog P-152-A on ladles and pouring systems . . .**

Company ....

Street .... **Box** ....

City .... **Zone** .... **State** ....

My Name ....

published by

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Golf & Wolf Roads,

Des Plaines, Ill.

VAnderbilt 4-0181

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MODERN CASTINGS is indexed by Engineering Index, Inc., 29 West 39th St., New York 18, N. Y. and microfilmed by University Microfilms, 313 N. First St., Ann Arbor, Mich.

The American Foundrymen's Society is not responsible for statements or opinions advanced by authors of papers or articles printed in its publication.

Published monthly by the American Foundrymen's Society, Inc., Golf & Wolf Roads, Des Plaines, Ill. Subscription price in the U.S., $5.00 per year; elsewhere, $7.50. Single Copies 50c. April, May and June issues $1.00. Entered as second-class mail at Pontiac, Illinois. Additional entry at Des Plaines, Ill.

Circle No. 802, Page 7-8

BONUS

september, 1958
vol. 34, no. 3

modern castings

features

departments

featurettes

TOGETHERNESS:
Maintenance & Mechanization

In this issue of MODERN CASTINGS the subject of foundry maintenance is dealt with in just about all of its many ramifications—what it is, how to establish a program, its importance and what it will do for you in your shop. Maintenance & Mechanization go together like Cope & Drag. One is useless without the other. And their mutual dependence is destined to grow with each passing year. As mechanization and automation continue to increase in the metalcasting industry, successful plant operation becomes more and more dependent on maintenance.

Good maintenance has to become a part of every foundryman's thinking—and not an afterthought. The old attitude of repairing equipment when it breaks down might be called maintenance by CRISIS. And the maintenance department resembles a fire department continually running from one breakdown to another! This practice is fast giving way to the realization that considerable thought and planning must be expended in a continuing program of equipment maintenance to prevent or minimize breakdowns. In today's modern integrated foundry a single breakdown in one key spot can easily idle half the working force!

The five feature articles and three technical papers published in this issue contain many ideas that can help you establish or improve a foundry maintenance department. This department is the "crutch" on which mechanized production must lean. Maintenance personnel must be skilled, well trained and well equipped to treat the ailments of mechanization and automation—namely fractures, abrasive wear, short circuits, overheating, corrosion and leaking.

In the past few years more attention has been directed toward a new phase of maintenance—PREVENTIVE MAINTENANCE. Preventive maintenance, often referred to as P.M., is a kind of insurance that protects your plant and its equipment from undergoing the hardships of breakdown and repair. P.M. programs determine what can be done economically to prevent equipment breakdowns before they occur. Preventive maintenance extends the "life expectancy" of equipment; it minimizes safety hazards; it reduces costs of repairs; it insures continuous plant operation at lowest possible cost; it maintains worker's confidence in the ability of the machine to do the job. Lubricating, cleaning and inspecting lead the P.M. attack on breakdown. All the details for setting up a preventive maintenance program in your foundry are covered in this issue.

Manufacturers have developed numerous products to help with foundry maintenance. A special product guide is included in September MODERN CASTINGS to show you the materials and equipment available for lubricating, protecting, cleaning and repairing your foundry facilities.

Remember, Preventive Maintenance is the stitch in time that saves nine.—Editor

MASTER KEY TO A NUMBER OF SITUATIONS! Vancoram V-5 Foundry Alloy is a chromium alloy balanced with silicon and manganese. By varying the addition of V-5 between ¼% and 1½%, a *single iron* can be made adaptable to a wide range of section sizes. This represents savings in any foundry! Add these benefits, too: improved mechanical properties, density, uniformity . . . reduced chill, without formation of open structures in heavier sections . . . elimination of chilled corners and edges, resulting in improved machinability. V-5 Foundry Alloy means better castings at lower cost! For all the facts and for a free copy of an informative brochure on the subject, call or write your nearest VCA District Office.

Producers of alloys, metals and chemicals

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OF AMERICA

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5470—Foundry—September; Modern Castings—September; American Metal Market—September 23, 1958

Circle No. 803, Page 7-8

obituaries

W. H. Eisenman, 73, 40 years national executive secretary for the American Society for Metals, died May 30. Born in Jamestown, Ohio, 1886, he received a master's degree in chemistry at Stanford University. In 1918, while in his early 30's and superintendent of public schools in Elmhurst, Ill., he was asked by Theodore Barker, owner of a heat-treating business in Chicago, to act as general manager for the newly organized American Steel Treaters Society.

During the first years of the new Society, Eisenman traveled from city to city, organizing chapters at the rate of over one a month. During this first year, he established the National Metal Exposition, held each year since that time.

Some of the technical accomplishments achieved under his leadership are *Metal Progress*, first published in 1930; *Metals Review;* and the *A. S. M. Metals Handbook*, starting in 1924 as a collection of "recommended practices" in looseleaf form.

Eisenman's plans for the future included establishment of an A.S.M. Metal Science University, offering courses in metal science only, extending from the third-year university level through post-graduate work.

An honorary degree of Doctor of Laws was conferred posthumously upon Eisenman by Western Reserve University, Cleveland, June 11.

R. C. Van Hellen, 57, production manager, Unitcast Corp., Toledo, Ohio, died recently. He was immediate past membership chairman and former treasurer, AFS Toledo Chapter. Van Hellen had served the company since 1923.

L. M. Nesselbush, president and general manager, Falcon Foundry Co., Lowellville, Ohio, died. He was a member of the original board of directors, Non-Ferrous Founders' Society, serving as its vice-president for the 1946-47 term.

J. R. Bodine, president, Bodine Pattern & Foundry Co., St. Louis, died June 20. He was president of the company since founding it in 1912. A past director of the AFS St. Louis District Chapter, Bodine was also a member, Non-Ferrous Founders' Society St. Louis Chapter.

pouring off the heat

Questions on answers

■ We read with great interest your recent Questions and Answers column where a Mr. K. R. asked the question:

"We are just beginning to investigate the cost of installing dust-collecting equipment and wonder if there is any rule of thumb to guide us in determining the relative cost of the various types on the market?"

Your answer was: "There are four basic types of cupola emission collectors: 1) Electrostatic, 2) Fabric, 3) Centrifugal, and 4) Wet. The installation costs can be best be compared by reducing costs to a common denominator of cubic feet per minute of standard tuyere air handled. On this basis the four types would cost, respectively, \$10, \$9, \$7 and \$6 per CFM of standard tuyere air passing through the collector. For a cupola with a 30 ton per hour melting rate, the installation costs for the four types would be approximately \$130,000, \$117,000, \$91,000 and \$78,000."

We are pleased to advise of a fifth method for collecting dust which is a combination of #3 and #4 with some refinements. It would be a wet impingement-centrifugal combination collector manufactured by Joy Manufacturing Co.

We can offer substantial savings on a common denominator or a per CFM basis because of light weight, ease of installation, and low maintenance. I would venture to say our installed cost on the same basis as you have answered would be perhaps less than \$50,000.

L. E. Fields
Joy Manufacturing Co.
Chicago

Grateful guests

■ Before the members of the German Foundrymen's Society returned to Germany, they requested us to convey their sincere gratitude to you for the wonderful assistance and cooperation in setting up the program for their study tour through the United States.

May we join the visitors in thanking you for everything you have done on their behalf, and which contributed so much to the success of their study trip.

Karl Reder
Trade and Industry Tours Association, Inc.
New York

Increasing numbers of cost-conscious foundrymen are intelligently asking, "How much?", as the question relates directly to production results in their plants.

Soul-searching VALUE ANALYSIS is surely welcomed by every serious supplier who has a true value to offer.

ADM, for one, encourages questions relating to the price of our binders, because they offer a perfect opportunity to point up the HIDDEN VALUES rarely appreciated in a unit price . . . the *true* values that express themselves in less scrap, reduced cleaning, faster production, greater profit, and more satisfied customers.

(HIDDEN VALUE NO. 1)
QUALITY . . .

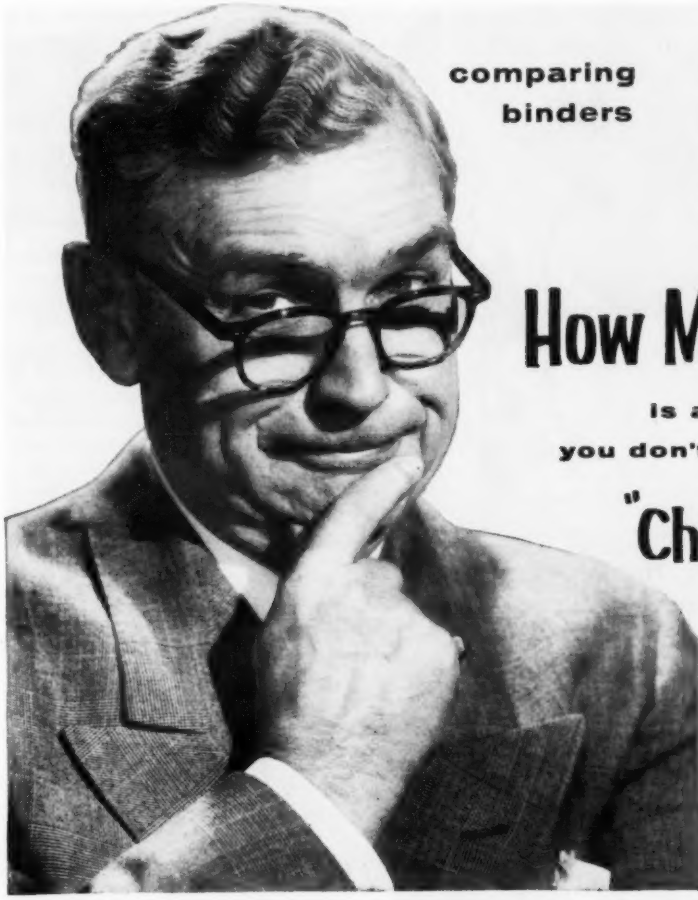
YOU SAVE WITH ADM's CONTROLLED QUALITY AND UNIFORMITY. Upset the delicate balance of a smooth running foundry by an off-standard batch of binder and you can easily eat up every cent you saved in the original price. The unmatched quality and uniformity of ADM supplies are insurance against profit-consuming errors that reflect themselves in swelling scrap piles and discontented customers.

(HIDDEN VALUE NO. 2)
SERVICE . . .

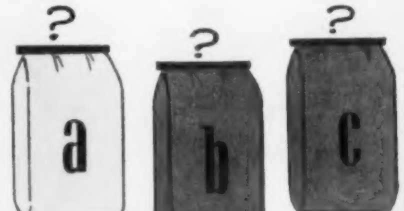
YOU GET COMPLETE FIELD SERVICE with every ARCHER product. ADM's national organization of experienced Representatives, Product Managers, and Technical Field Service trouble-shooters provide you with specialized counsel when you need it. They keep you informed, too, of the new product developments researched in the ADM laboratories. These trained foundry experts, none of which has "an axe to grind" for any single process, constantly feed you new ideas for speeding production, cutting costs and improving casting quality.

(HIDDEN VALUE NO. 3)
DELIVERY . . .

YOU CAN TAKE ADVANTAGE of quantity prices and lower freight rates by ordering carloads or truckloads of mixed products instead of paying the "long" price for L.C.L. or L.T.L. shipments. This procedure, which also helps improve your inventory control, is made possible by ADM's complete line of binders, washes, facings, and supplies for every foundry process produced and stocked in conveniently-located plants and warehouses throughout the U.S. and Canada.



comparing binders



How Much a Pound ?

is a good question . . . IF you don't expect the answer to be,

"Cheapest Price!"

. . . for cheapest price, attractive as it looks at first glance, usually means a disappointment in quality, service, or delivery.

Archer Daniels Midland company
FEDERAL FOUNDRY SUPPLY DIVISION
2191 West 110th Street • Cleveland 2, Ohio

Archer QUALITY

THERE'S HIDDEN VALUE IN ADM PRODUCTS AND THERE'S A PRODUCT FOR EVERY PROCESS

GREEN BOND BENTONITE . . . for mold facings

ADCOSIL . . . for CO_2 cores

LINOIL . . . for oil-sand cores

ADMIREZ . . . for shell cores and molds

LIN-O-SET . . . for air-setting cores

and a complete line of FACINGS, WASHES, and SEA COAL

Circle No. 804, Page 7-8

with MELTERS
WHO KNOW
CUPOLAS BEST

It's *Famous*
CORNELL
CUPOLA FLUX
Every time . . .

For a few cents per ton of metal, famous Cornell Cupola Flux brings you cleaner iron—better castings. That's because here is a superior flux that is a scientifically prepared mixture of high grade fluorspar and other materials which cause a chemical reaction in molten iron giving you greater fluidity of slag and complete cleansing of coke.

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Manufacturers of Iron, Semi-Steel, Malleable, Brass, Bronze, Aluminum and Ladle Fluxes—Since 1918
Circle No. 805, Page 7-8

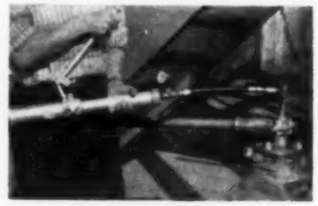
You'll want more information about these

products for better maintenance

Circle numbers on the Reader Service Card, page 7 and 8, corresponding to numbers beneath these items; and manufacturer will mail you descriptive literature.

Lubrication

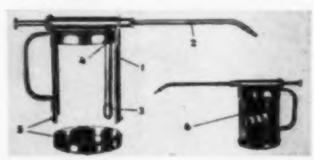
PLUG VALVE LUBRICATION . . . by high-pressure, hydraulic action, features locking of hose and coupler to valve-shank buttonhead fitting.



Hand gun automatically indicates when correct lubricant pressure has been developed. *Rockwell Mfg. Co.*
For Manufacturer's Information Circle No. 601, Page 7-8

LUBRICATION FITTINGS . . . designed to eliminate conventional relief plugs, are said to cut lubricating time 80 per cent. Simplify lubrication of anti-friction bearings in motors, pillow blocks or any ball or roller-bearing housing equipped with relief plugs. *Keystone Lubricating Co.*
For Manufacturer's Information Circle No. 602, Page 7-8

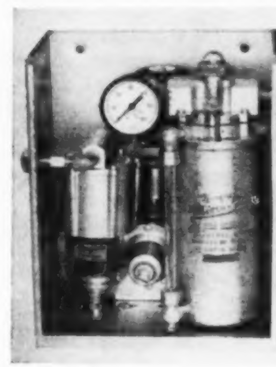
HIGH PRESSURE OILER . . . quickly attaches to any standard quart size oil can, said to handle light, medium and heavy viscosity oils up



to 60 SAE at below zero temperatures. Can be placed upside down or on its side without leakage. *Buerkens Corp.*
For Manufacturer's Information Circle No. 603, Page 7-8

TROLLEY WHEEL LUBRICATOR . . . automatically lubricates every wheel on both sides without stopping the production line. Measured amount of lubricant applied whether wheels spaced yards apart, spaced irregularly or as close as 6-in. Reservoir contains 25,000 shots of oil or grease, claimed to be sufficient for average 1000-wheel system with once-a-week lubrication for three months. *Alemite Div., Stewart-Warner Corp.*
For Manufacturer's Information Circle No. 604, Page 7-8

MICRO-FOG LUBRICATION . . . units totally enclosed in splash-proof cabinets which can be locked to prevent tampering with adjustments. Delivers controlled amount of air-borne



lubrication. One or two quart capacity, optional liquid level control which sounds alarm or stops machine when oil supply low. *C. A. Norgren Co.*
For Manufacturer's Information Circle No. 605, Page 7-8

GRAPHITE LUBRICANT . . . which provides inert, dry-film lubrication for moving parts is available in one and five-gal. drums. Forms heat and friction-resistant film seconds after application. Officials claim effective lubrication 100 F below zero to 800 F. *American Resin Corp.*
For Manufacturer's Information Circle No. 606, Page 7-8

WIRE LUBRICANT . . . new extra-low-friction compound for coating the wire is said to facilitate pulling through conduit with less than half the effort required by paraffin coating. Officials state compound will not

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flake off when scraped. *Rome Cable Corp.*

For Manufacturer's Information Circle No. 607, Page 7-8

DRY LUBRICANT . . . sprayed on with aerosol attachment eliminates need for oil can, rags and brushes. Said to dry instantly, will not pick up abrasive dirt and dust, will not soil materials or machines and is unaffected by moisture, cold or heat. Dries quickly, providing durable film of lubricating graphite. *Joseph Dixon Crucible Co.*

For Manufacturer's Information Circle No. 608, Page 7-8

CENTRALIZED LUBRICATION . . . distributes measured amount of lubricant to individual bearings or surfaces from a central reservoir or pump. Lubrication accomplished while machine is running, saving down-time and man-hours. Said to be applicable to all types of machinery. *Trabon Engineering Corp.*

For Manufacturer's Information Circle No. 609, Page 7-8

Repair

HOSE AND CABLE MAINTENANCE . . . facilitated with one-piece clamp. Said to be capable of rapid

application and removal without special tools—holding strength above hose bursting pressures. *Circle Clamp Corp.*

For Manufacturer's Information Circle No. 610, Page 7-8

PALLET MAINTENANCE . . . technical pamphlet intended as guide to users in preventing damage to wooden pallets plus repair suggestions. *National Wooden Pallet Manufacturers' Association.*

For Manufacturer's Information Circle No. 611, Page 7-8

HEAVY PULLING JOBS . . . solved with portable hydraulic pullers, 30-100-ton capacity, both solid and center-hole with built-in self-contained hand pumps. Used at site of maintenance trouble, saving hauling and dismantling. *Templeton, Kenly & Co.*

For Manufacturer's Information Circle No. 612, Page 7-8

PERMANENTLY BONDED REPAIRS . . . without welding and soldering possible with plastic adhesive

At Grinnell, molten iron is poured from air furnaces 16 hours a day (above) to produce over 2,000 different types and sizes of castings like those shown at right.

Grinnell uses HANNA SILVERY at their Columbia, Pa., plant to help maintain close silicon control

Grinnell Corporation is nationally known for its automatic sprinkler systems—a line relied on for dependable fire protection by thousands of American businesses. For these systems, and for its piping supply sales throughout the country, Grinnell at its Columbia, Pa., plant annually produces over 100 million malleable iron castings of uniform quality and dependability—pipe fittings, pipe hangers and supports from ⅛" I.D. elbows to 6" I.D. tees.

Every one of more than 2,000 patterns, many of them intricate, is cast from the same mixture. An all-important part of this mixture is Hanna Silvery Pig Iron. Grinnell metallurgists have found that Hanna Silvery, with its dependable analysis, gives them the silicon control so essential to the uniform qualities required in sprinkler systems and pipe fittings.

In addition to Silvery, Hanna produces all regular grades of pig iron, including HannaTite, a specially controlled close-grain iron. All are available in the popular 38-pound pig and the smaller HannaTen ingot.

Ask your Hanna representative how he can help solve your pig iron problems. He is an expert and as close as your telephone.

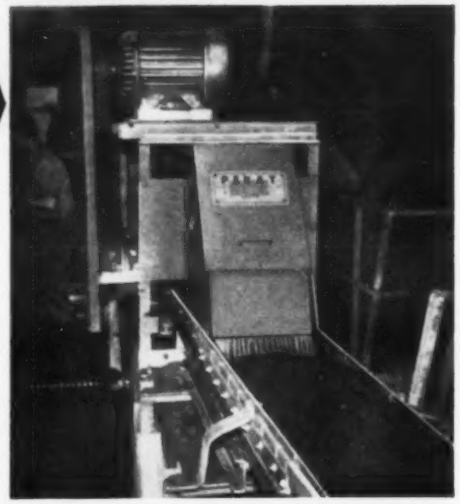
THE HANNA FURNACE CORPORATION
Buffalo • Detroit • New York • Philadelphia
Merchant Pig Iron Division of
NATIONAL STEEL CORPORATION

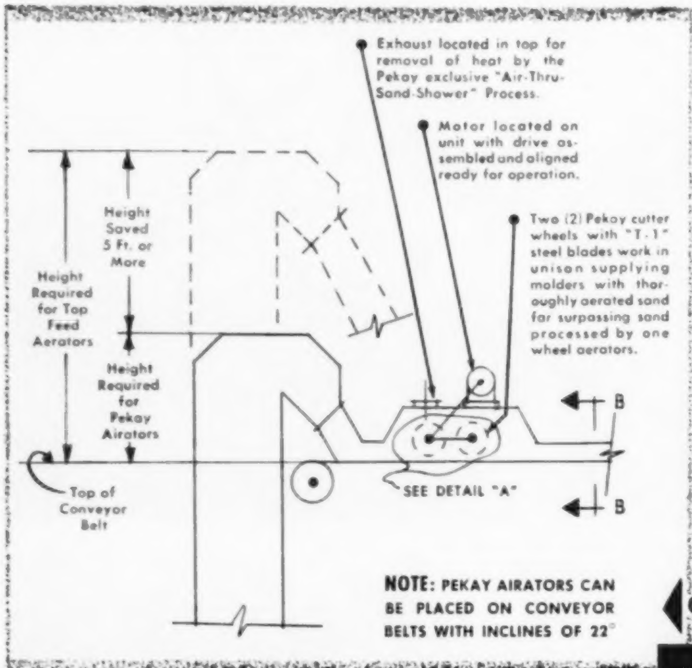
HANNA
THE BEST KNOWN NAME IN IRON

Circle No. 806, Page 7-8

FOR THE BEST BLENDING and AERATING AT THE LOWEST COST, INVESTIGATE PEKAY BEFORE YOU BUY

The Pekay Airator requires no special supports. Unit fits right on your present conveyor channels requiring little space and can be placed anywhere in your sand system in less than 25 man hours.





ECONOMIZE TODAY WITH PEKAY

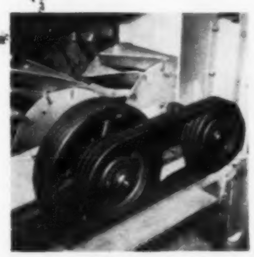
SAVE
- On reduced machining and scrap losses
- On lower operating and maintenance
- On easier and faster installation
- ON LOWER ELEVATOR AND BUILDING REQUIREMENTS

Specifications:

Belt Width	Cutter Wheel Diameter	Maximum Sand Head	Capacity for belt Traveling 100 FPM
18	12	3½	40 T. P. H.
24	16	5½	125 T. P. H.
42	20	8½	410 T. P. H.

Pekay Airators can be made for any belt width and capacity

Every unit guaranteed to meet customer requirements



DETAIL "A"
Easy access to parts. Complete wheel replacement takes less than 2 hours. Wheel life averages two years on 40 hour week operation.

SECTION "B-B"
Cutter wheels traveling at 500 to 600 RPM thoroughly fluff, aerate, cool and break all lumps except core butts the size of pencil erasers.

PEKAY MACHINE & ENGINEERING CO. INC.
866 N. SANGAMON STREET CHICAGO 22, ILLINOIS

Specialists in foundry sand conditioning and handling, slurry systems, engineering and equipment

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- ☐ Pekay Mixer Mullers
- ☐ Pekay Coolerators
- ☐ Pekay Sand Systems
- ☐ Pekay Airators
- ☐ Pekay M-T-Matic Buckets

Circle No. 807, Page 7-8

which eliminates use of hardeners. Heat-reaction links dissimilar materials into permanent bond. Said by manufacturer to never shrink or contract and to withstand 600-ft lb of impact per sq. in. *Schramm Fiberglass Products.*

Circle No. 613, Page 7-8

WATER FLUSH DRILLING . . . unit includes heavy-duty, 1000 rpm drill motor with water swivel which supplies water to cutting face of dia-

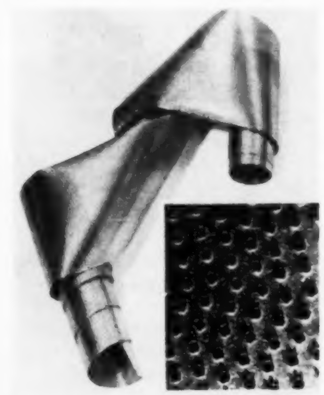
mond drill, flushing away cuttings. Water fitting connects to either ordinary supply line or portable, pressure water tank. *Wheel Trueing Tool Co.*

Circle No. 614, Page 7-8

EMERY-BASED FLOOR PATCHING . . . material reportedly permitting fast concrete floor repairs, without danger of softening, rutting out or poor adhesion, becoming serviceable overnight. Patching material requires no additives other than water. *Walter Maguire Co.*

Circle No. 615, Page 7-8

FLEXIBLE, ALL-STEEL SANDPAPER . . . provides total of 750 cutting sides per sq in. Manufacturer states product outlasts conventional sandpaper 10 times, and out-cuts it five



to one. Reported to quickly rasp, sand and smooth, hard and soft woods, plaster, plastics and soft metals. *Red Devil Tools.*

Circle No. 616, Page 7-8

SEAL OIL LEAKS . . . with stick form sealant. Stops leaking through cracks, pinholes or rusty parts. Leak-proof seal under moderate pressure of fuel, vegetable or tar oils, and gasoline. Manufacturer claims new stick form sealant stops leaks immediately, even while oil is running through cracks or splits. *Lake Chemical Co.*
For Manufacturer's Information Circle No. 617, Page 7-8

FLOOR PATCHING, RESURFACING . . . with epoxy concrete material claimed to possess tremendous bond strength, quickly drying to dust-free surface. Company states maintenance material can be "pulled out" to feather edge in patching without reducing inherent properties used on almost any type rigid floor, wall or ceiling. *American Metaseal Corp.*
For Manufacturer's Information Circle No. 618, Page 7-8

FLOOR RESURFACING . . . compound reported to withstand loads up to 50,000 lb immediately after application. Three application steps; prime, fill and tamp. Request bulletin. *National Asphalt Corp.*
For Manufacturer's Information Circle No. 619, Page 7-8

LIGHT-WEIGHT SPRAY GUNS . . . for general maintenance and paint jobs. Designed for use with external mix nozzle so that fast drying materials may be sprayed without nozzle build-up. *Binks Mfg. Co.*
For Manufacturer's Information Circle No. 620, Page 7-8

CONTOUR-GRIP VICE . . . adapts to all shapes and contours, insuring non-wobble grip for small-part maintenance. Gripping pressure evenly distributed. *American Positive Grip Vise Corp.*
For Manufacturer's Information Circle No. 621, Page 7-8

Records

PUSH-BUTTON FILING . . . maintenance system automatically selects and positions any of 60 visible index slides at push of button which is said to greatly reduce operating and space costs. *Remington Rand Div., Sperry Rand Corp.*
For Manufacturer's Information Circle No. 622, Page 7-8

MACHINERY MAINTENANCE . . . system said to eliminate failure, fatigue, vibration, wear and noise in machinery having rotating components. Machinery is inspected with company's new vibration meter which shows correction needed to balance rotating equipment. *International Research and Development Corp.*
For Manufacturer's Information Circle No. 623, Page 7-8

Sterling flasks are made to cope with tough foundry production schedules!

• You may ask: "Why do Sterling Flasks seem to last forever, even when subjected to tough foundry usage?" The answer is simple. Sterling uses *rolled steel* — not pressed steel. Tensile strength of 70,000 p.s.i. adds many years of hard service life. Made of special hot rolled steel channel, with controlled copper bearing and carbon content, Sterling Flasks are welded into one solid, rigid piece. In addition, a center-rib is rolled into each section to fortify against torsional and other strains. You get heavy flanges with square corners and full width bearing. Partings are accurately machined to .005″ precision. Yes — Sterlings are built for a long life of hard service. They enable you to produce better castings at a bigger profit. Write today for Sterling Catalog.

Sterling

STERLING NATIONAL INDUSTRIES, Inc.
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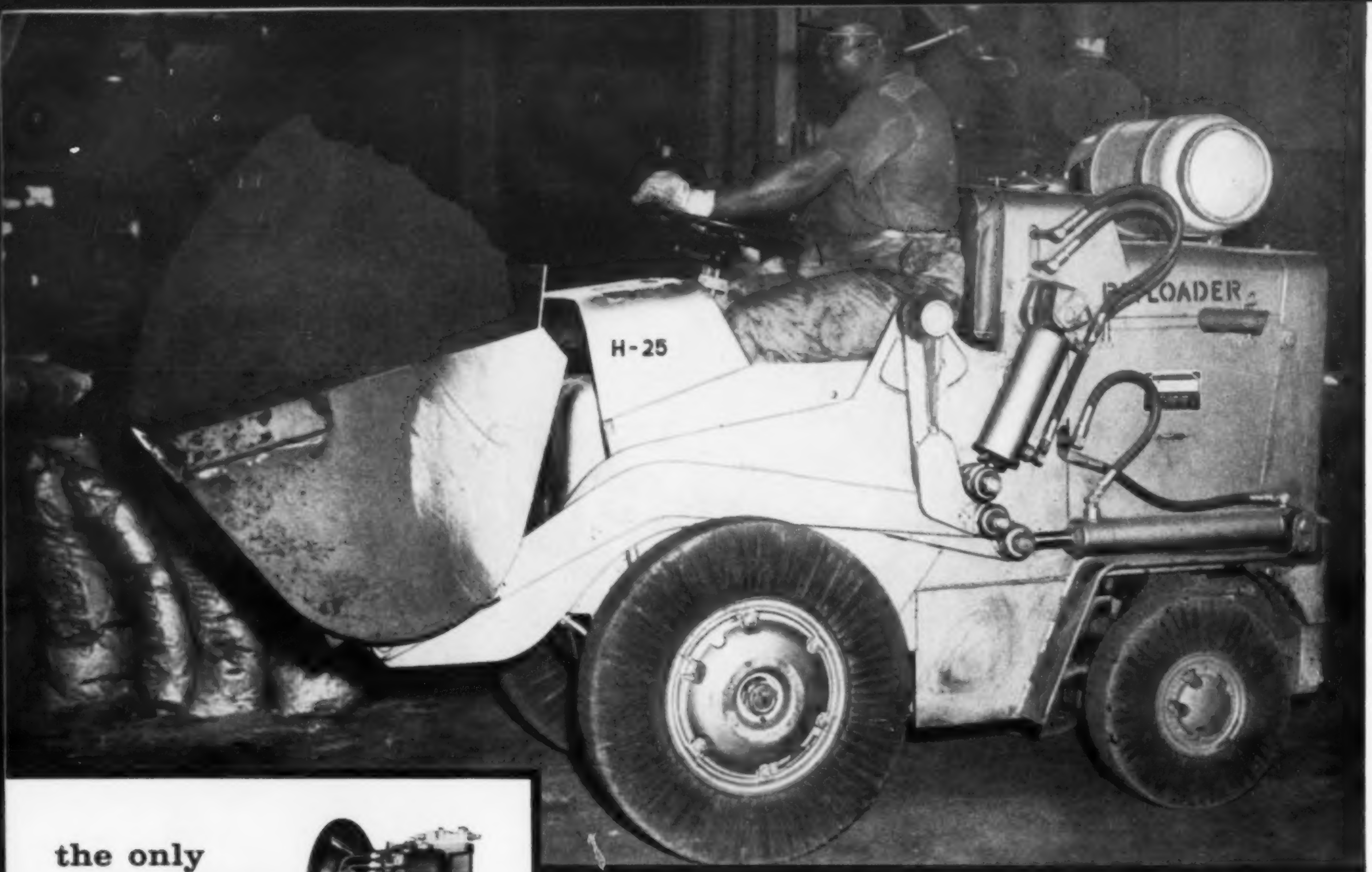
Subsidiary Company:
STERLING FOUNDRY SPECIALTIES LTD.
LONDON • BEDFORD • JARROW-on-TYNE — England

Manufacturers of Foundry Equipment for Almost a Half Century!

Circle No. 808, Page 7-8



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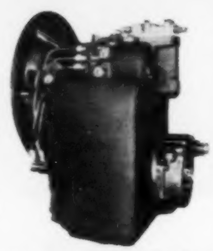
COMPLETE

power-shift transmission



. . . having two speed ranges forward and two in reverse — the low range for digging power and close maneuvering—the high range for fast, economical travel in either direction.

All shifting, forward or reverse, is an instant finger-tip action with no need to stop between range shifts. The torque-converter is carefully matched with the transmission and is the more costly and more efficient two-phase type that automatically becomes a thrifty fluid drive when torque multiplication is not needed. Transmission and converter also keep comfortably cool because their oil is radiator-cooled.

THE FRANK G. HOUGH CO.

711 Sunnyside Ave., Libertyville, Ill.

Send full data on the H-25 PAYLOADER.

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H-25 { . . . geared for penetration . . . geared for transportation

This new "PAYLOADER" has more hustle than you've ever seen in a tractor-shovel. It's got everything to turn out big production all day long with the least operator effort and is the only machine in its class with *complete* power-shift transmission and power-steer. The carry capacity of 2,500 lbs. is 25% greater than has ever before been available in a tractor-shovel of its size and maneuverability, yet it easily goes in and out of boxcars with narrow 6-foot doors.

Another valuable and exclusive feature is the power-transfer differential that makes traction more effective and reliable at all times because the wheel with the better grip automatically gets the most power.

The H-25 is *full* of other plus features that mean more production, less maintenance and longer life: closed hydraulic system, wet-sleeve overhead valve engine, triple air cleaners, full-shift fuel capacity, 4,500 lbs. of bucket breakout force and 40° bucket tip-back, to mention only a few.

Your Hough Distributor wants to show you how the greater capacity, speed and handling ease of the H-25 can cut your bulk-handling costs. Ask him about Hough Purchase and Lease Plans too.

Modern Materials Handling Equipment

THE FRANK G. HOUGH CO.

LIBERTYVILLE, ILLINOIS

SUBSIDIARY—INTERNATIONAL HARVESTER COMPANY

RAILROAD TRACK MAINTENANCE . . . inspection kit provides check-list for determining condition of track, emphasizing areas which need correction or replacement. Contains forms which serve as permanent record of inspection and as requisition memos to purchasing department. *L. B. Foster Co.*

For Manufacturer's Information Circle No. 624, Page 7-8

PLANT MARKING KIT . . . for identifying lubrication points on plant equipment. Markings are transfer type, claimed to be abrasion and oil-immersion resistant. Company also has kit of over 475 markings designed for water, heating and air-conditioning systems. *Meyercord Co.*

For Manufacturer's Information Circle No. 625, Page 7-8

PREVENTIVE MAINTENANCE SYSTEM . . . pinpoints parts on individual machines that should be replaced before they break down. Progressive signals show inspection schedule and colors indicate type of work to be done. Space provided for listing spare parts to be kept on hand. *Acme Visible Records, Inc.*

For Manufacturer's Information Circle No. 626, Page 7-8

FORK TRUCK MAINTENANCE . . . chart for preventive maintenance of electric trucks pinpoints 28 areas which should be inspected daily, weekly or monthly. Blocks in the chart are initialed upon inspection; manufacturer says that proper follow-through on use of chart will insure trouble-free operation. *Lewis-Shepard.*

For Manufacturer's Information Circle No. 627, Page 7-8

DRUM-HOISTING SLING . . . of wire rope designed to hoist three

Circle No. 809, Page 7-8

drums at a time in safe, fast lift. Manufacturer claims no possibility of shifting or falling out of sling. Drums held tightly together by their own weight. *Lowery Brothers, Inc.*
For Manufacturer's Information Circle No. 658, Page 7-8

AUTOMATIC DATA PROCESSING . . . machine provides speed and accuracy for over-all plant control as well as maintenance scheduling. Tabulating cards are punched according to requirements of maintenance scheduling. Work schedule for functions such as oiling, cleaning determined in minutes. *Royal McBee Corp.*
For Manufacturer's Information Circle No. 628, Page 7-8

Personnel

VIBRATION CONTROL . . . is important to effective maintenance. Simple-to-use, inexpensive neoprene pads

control vibration, absorb impact and reduce noise. *MB Mfg. Co.*
For Manufacturer's Information Circle No. 629, Page 7-8

MAINTENANCE TRAINING . . . courses given on-the-job for customer's floor maintenance personnel. Anti-slip floor polish manufacturer

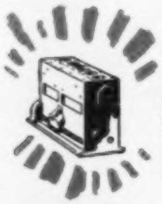
supplies services of trained floor specialist who designs program for regular floor upkeep, explaining proper procedures to maintenance crew. *Walter G. Legge Co.*
For Manufacturer's Information Circle No. 630, Page 7-8

SHOP TOWEL DISPENSING . . . is automatic with unit designed to dispense bundles of five clean towels quickly. Towels dispensed only after worker deposits five soiled towels in machine. Counting device for effec-
Continued on page 15

Circle No. 810, Page 7-8

NARCOLINE NARCOLINE NARCOLINE NARCOLINE

Slag-Resistant Plastic Refractory



NARCOLINE Assures Cleaner Castings

It successfully resists the erosive and corrosive action of metals and slags, eliminating refractory inclusions from the casting.

NARCOLINE Facilitates Metal Flow

It resists graphite burn-out under operating conditions, and maintains a lasting lubricated surface for easy metal flow.

NARCOLINE Assures Easy Slag Removal

It resists the wetting action of molten metal and slag, permitting ladles to be cleaned of solidified metal and slag with little effort.

NARCOLINE Easy to Install

It can be rammed to any desired shape with mallet or air hammer. Requires no special training to install.

NARCO

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Circle No. 811, Page 7-8

the editor's field report

by Jack Schaum

■ One of the by-products of increased Mechanization is the increased importance of maintenance—both preventive and on-the-spot. Shut-downs and slowdowns arising from mechanized breakdown are costly diseases of mechanized foundry operations. The growing importance of the maintenance department in every metalcasting plant has prompted Modern Castings to focus attention on the whys and hows of in-plant maintenance with its September issue. Feature articles, Transactions papers and special departments will tell you how higher productivity and bigger profits are coming from better foundry MAINTENANCE programs.

■ Do you have grease fittings on foundry equipment that are next-to-inaccessible? Can't reach them without a step-ladder? Need a blood-hound to find them? Then try this gimmick used by Chicago Hardware Foundry Co. . . . Slip one end of a length of plastic tubing over the hidden grease fitting and extend it to some convenient spot. Put an adapter on the other end of the tubing and use a conventional grease gun to pump lubricant 10 or 20 ft to the points subject to frictional wear . . . they also run the same kind of tubing from the bottom of small oil reservoirs to rotating shafts, providing continuous lubrication by gravity feed.

■ At the recent AFS Show in Cleveland one exhibitor introduced a new maintenance-free material that is destined to solve many a problem in the metalcasting industry. By blending fiber glass with synthetic rubber a combination of properties has resulted that has lent itself to making pipe and liners for withstanding extremes of abrasive wear. Shaped into pipe, this material is demonstrating its toughness in pneumatic sand conveyors and in dust collecting systems. One imaginative foundryman uses the pipe to convey castings down from the fourth floor by gravity. Endowed with good damping capacity, the fiber glass-rubber piping eliminates much of the noise in the foundry that emanates from conveyor systems. Sheets of the material are used to line abrasive cleaning and tumbling equipment thereby reducing the wear and tear associated with metal-to-metal contact.

■ Considerable discussion was stirred up by R. C. Shnay, Canada Iron Foundries, Ltd., Toronto, Ont., during the Heat Transfer Clinic at the 62d Castings Congress when he described an unusual way of improving riser efficiency. By placing some old automobile headlight reflectors over the risers he was able to prolong their feeding life by reflecting radiant heat back into the metal. Feeding time of risers was extended as much as two to three times. Certain refinements on the original equipment included the use of polished stainless-steel reflectors and the lining of reflectors with expendable aluminum foil. Now you can add back-reflection to that bag of foundrymen's tricks that already includes insulated riser sleeves and exothermic hot-topping.

maintenance products

Continued from page 13

tive control of towels, registering number of towels used and eliminating need to count soiled towels. *Industrial Wiping Cloth Co.*

For Manufacturer's Information Circle No. 631, Page 7-8

MANAGEMENT PROGRAM . . . for maintenance detailed in 12-p, illustrated folder. Covers repair, construction and prevention programs, and proper utilization and scheduling of maintenance personnel and control of inventories. *Remington Rand, Div., Sperry Rand Corp.*

For Manufacturer's Information Circle No. 632, Page 7-8

Clean-up

POWER CONVERTING . . . attachment makes a riding-type power sweeper from motorless sweeper. Attachment said to give floor sweeper as much sweeping capacity as big

sweepers costing up to five times more. Forward or backward speeds up to 5 mph. Manufacturer claims attachment can also be used for snow plowing, mowing grass, sweeping leaves and hauling loads up to a ton. *Handling Devices Co.*

For Manufacturer's Information Circle No. 633, Page 7-8

PORTABLE DISPOSALS . . . designed to burn 4-6 drums of waste per day; units capable of continuous 8-hr per day burning. Three burning capacities; accessories include low-blast gas burner, timer and induced draft fan. *Joseph Goder Incinerators.*

For Manufacturer's Information Circle No. 634, Page 7-8

FLOW CONTROL VALVE . . . affords unusually precise control of air, gas or low pressure hydraulic flow with unrestricted return. Flow regulated with fine adjustment from cut-off to full flow. *Valvair Corp.*

Circle No. 659, Page 7-8

BATTERY POWERED SWEEPER . . . designed to sweep full 8-hr sweeping shift without recharge. Filter automatically empties when hop-

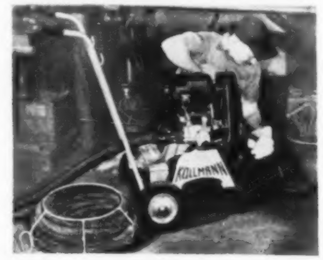
Circle No. 812, Page 7-8

Circle No. 813, Page 7-8

per is dumped, avoiding removal of filter or air blow-back for cleaning. Improved sweepability and rugged construction claimed. *Wilshire Power Sweeper Co.*

For Manufacturer's Information Circle No. 635, Page 7-8

DRAIN CLEANING . . . machine, one-half hp, handles up to 200 ft of 1-1/4-sectional cable for clearing 3-6-



in. lines. Adaptable for cleaning of lines as large as 10 in. and as small as 1-1/4-in. Mounted on ball-bearing wheel dolly. *Kollman Mfg. Co.*

For Manufacturer's Information Circle No. 636, Page 7-8

DUST CONTROL SWEEPING . . . unit, 7 ft 4-in. path power sweeper, uses high-powered vacuum system for controlling dust in heavy-duty plant and yard sweeping operations. Said to handle easily in congested areas. *G. H. Tennant Co.*

For Manufacturer's Information Circle No. 637, Page 7-8

VACUUM CLEANER . . . features "by-pass" head for wet or dry pick-up. Gallon capacity. *Kent Co.*

For Manufacturer's Information Circle No. 638, Page 7-8

LITTER ATTACHMENT . . . floor-mobile with litterdoor for suction floor cleaner designed for picking up bulky trash such as coffee cups, etc.,

as well as metal turnings and steel scrap. Operator can open litter door without stopping or slowing down cleaner. *Handling Devices Co.*

For Manufacturer's Information Circle No. 639, Page 7-8

EXTENSION SHAFT FANS . . . exhaust contaminated fumes from hoods or tanks, spray-booth exhaust oven recirculation and other installations requiring isolation of fan motor from air stream manufacturer states. Corrosion resistant coatings for fan and for the extension tube available. The cast aluminum-magnesium alloy propellor balanced for peak efficiency. Fans available in nine diameters to 60 in. *Propellair Div., Robbins & Myers, Inc.*

For Manufacturer's Information
Circle No. 640, Page 7-8

STEAM TRAP MAINTENANCE . . . discussed in brochure describing the use of temperature-indicating crayons used to determine whether trap is operating properly. Crayons used to indicate that temperature of line below trap is lower than that of line above trap; this will be the case when steam trap is operating efficiently. *Tempil Corp.*

For Manufacturer's Information
Circle No. 641, Page 7-8

CLEAN, LUBRICATED AIR . . . for air tools, cylinders, motors, etc., provided by air-line controls consisting of air-line lubricator, water separator and air regulator manufacturer claims. Operates efficiently at flows 5-50 cfm, pressures to 125 psi. *Stewart Warner Corp.*

For Manufacturer's Information
Circle No. 642, Page 7-8

DUST-FREE AIR HAMMER . . . "inhales" dust and chips produced in drilling concrete, brick, etc. Dust is sucked up through hollow drilling steel and into special dust-extracting tanks eliminating health hazard. *Thor Power Tool Co.*

For Manufacturer's Information
Circle No. 643, Page 7-8

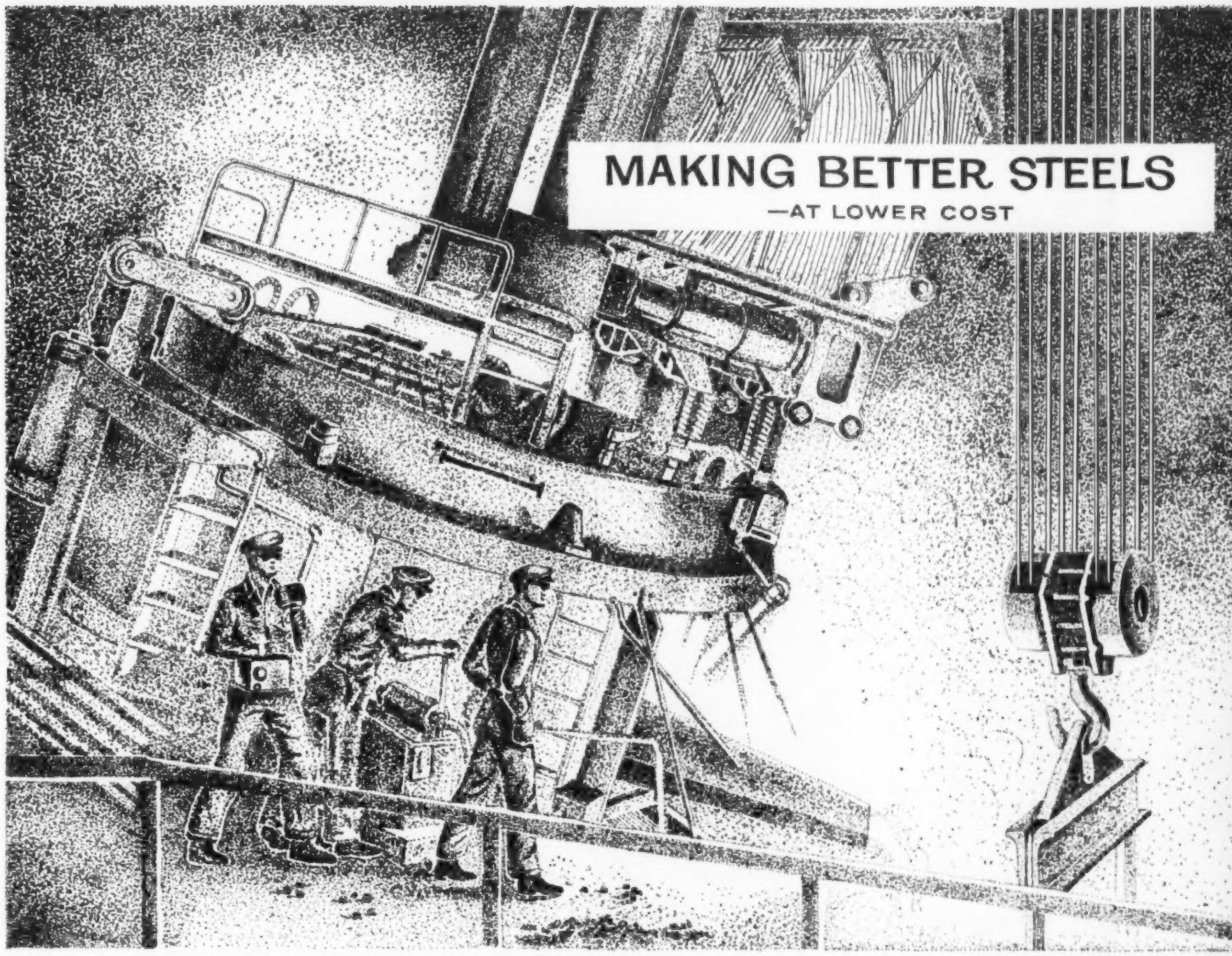
ALL PURPOSE ABSORBENT . . . said to soak up more than its own weight in oil, greases and other fluids. Provides dry, non-slip floor surface. Can be stored for long periods without caking or deterioration, according to manufacturer, and is chemically neutral and non-flammable. *Diversey Corp.*

For Manufacturer's Information
Circle No. 644, Page 7-8

SLUDGE COLLECTOR . . . reported to collect sludge, chips and waste oil from machine tool sumps and pits, transports it to disposal area and discharges it under pressure. Use circle number below to request informative bulletin. *Gorske Industrial Equipment.*

For Manufacturer's Information
Circle No. 645, Page 7-8

Circle No. 814, Page 7-8



TAPPING

. . . a heat at just the right pouring temperature is typical of the melter's technical mastery. Another important factor in making better steels at lower cost is the revolutionary **Unitrode® nipple** which "welds" the joints of **GLC Graphite Electrode columns.**

FREE—*This illustration of one of the skills employed by the men who make the metals has been handsomely reproduced with no advertising text. We will be pleased to send you one of these reproductions with our compliments. Simply write to Dept. C-9.*

ELECTRODE GLC DIVISION®

GREAT LAKES CARBON CORPORATION

18 EAST 48TH STREET, NEW YORK 17, N.Y. OFFICES IN PRINCIPAL CITIES

ROYER OFFERS A PRACTICAL SOLUTION TO HOT SAND PROBLEMS

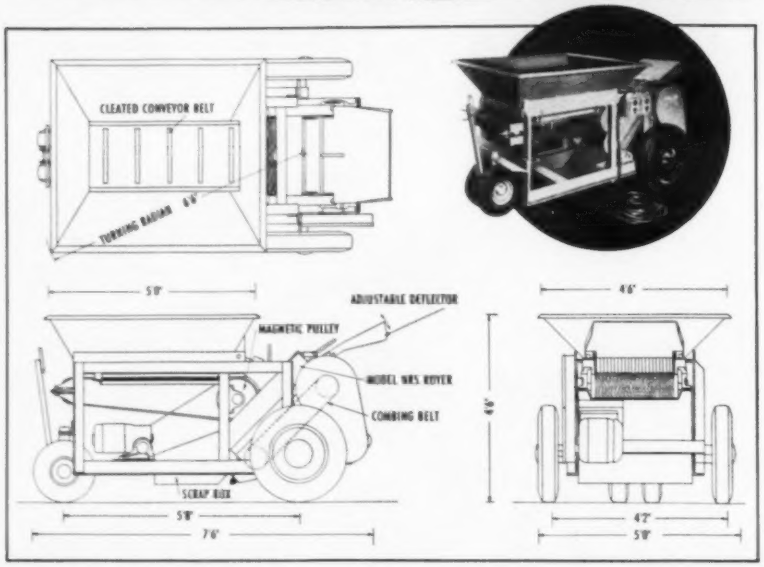
In today's foundry operation, time is probably the most costly element the superintendent must deal with. Sand used for today's casting must be conditioned and ready for use tomorrow. This frequently means sand conditioning at temperatures ranging up to 300° to 400°F.

These destructive high temperature operating conditions seem to plague every foundryman. Foundry equipment suppliers have offered many possible solutions—cooling towers, shake-out belt cooling, water cooling, rotary cooling, bin cooling, etc. But probably no manufacturer has offered more thorough cooling per dollar of invested capital than that obtained with Royer equipment.

All Royer Foundry Units employ the famous Royer Belt Combing Principle. In operation, a combing and mixing action takes place in the feed hopper. This breakdown of the hot sand mass releases the hot gases as the first step

in Royer Cooling. Further cooling of the individual sand particles takes place as the conditioned sand is discharged in an open stream. And finally, the sand heap, now open, light and fluffy, continues cooling at a very rapid rate.

There is a Royer Foundry Unit to solve every sand conditioning problem. Your inquiry is invited. We promise prompt reply—without obligation.



Sand Conditioning costs can be reasonable

When any industry suffers a business recession, however slight, the attention of its leaders automatically shifts to cost cutting and the elimination of waste. Many foundrymen peer wistfully at the large, highly mechanized foundry and imagine semi-automation is the answer.

Looking at the foundry industry realistically, this form of advanced mechanization is not the answer. Seventy-two per cent of the nation's foundries employ less than 50 men—for most of these, advanced mechanization is both a physical and an economic impossibility.

For these foundries, units like the highly efficient Royer MAGNA-SAN are the practical solution to most sand conditioning cost problems. Here is a unit that is foundry-engineered to magnetically clean, mix, blend and aerate shakeout sand right on the molding floor—and at a lower initial cost and with less maintenance than any other mechanical method.

The Royer MAGNA-SAN is ideally designed for use in the small and medium sized foundry—this 73 per cent who most need the advantages of mechanization but cannot pick up the bill. Compare this compact unit, in the drawing above, with your available working space. Notice how the compact design permits easy maneuvering about crowded casting floors.

Capacity-wise, the Royer MAGNA-SAN conditions 45 tons of sand per hour—a full 8 per cent more than its closest competitor. And remember, it is a fact that economy of operation is determined by performance, which is measured by comparative expense per ton of sand conditioned.

We invite you to see for yourself how reasonable sand conditioning costs can be. Send the coupon and we'll rush your copy of the MAGNA-SAN Bulletin RM57 to you by return mail.

ROYER FOUNDRY & MACHINE CO.

ROYER 155 PRINGLE STREET KINGSTON, PENNA.

I want to know more about reasonable sand conditioning costs. Rush me your MAGNA-SAN Bulletin.

NAME____________
COMPANY____________
ADDRESS____________
CITY______ ZONE______ STATE______

Circle No. 815, Page 7-8

Construction

AUTOMATIC LADDER LEVELING . . . device enables maintenance crews to position ladders on stairs and uneven levels. Fully automatic, ladder attachment locates upon placement and self-releases upon relocating the ladder, company states. Aluminum construction, easily attached to any length or width, straight or extension wood ladder and fits many metal ladders. *Anderson Architectural Steel Products, Inc.*

For Manufacturer's Information Circle No. 646, Page 7-8

FIBERGLASS LADDER . . . is claimed to be stronger and more durable than heavier conventional wooden ladders. Company reports exclusive design plastic-welds magnesium or aluminum rungs for life. Will not conduct electricity and resists warping. *Putnam Rolling Ladder Co.*

For Manufacturer's Information Circle No. 647, Page 7-8

PLASTIC PANES . . . for use in place of glass are said to eliminate maintenance costs due to glass breakage. Made from polyester resins, fiberglass and nylon strands, the panels are reported by the manufacturer to be easily and quickly installed. *Filon Plastics Corp.*

For Manufacturer's Information Circle No. 648, Page 7-8

OVERHEAD MAINTENANCE . . . unit designed for narrow aisle spaces and working heights of 20 ft. After rising above mast, platform swivels full 360 deg. Self-powered, unit

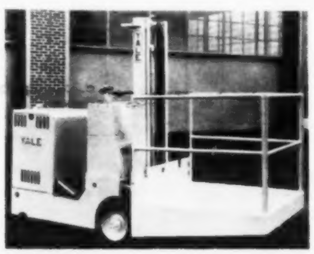
contains 32-gal. water system for cleaning, and electrical outlet for D.C. power tools or vacuum cleaner. One-man operated from platform. *Lift-A-Loft Co.*

For Manufacturer's Information Circle No. 649, Page 7-8

WORKING HEIGHT OF 41 FT . . . provided with hydraulic overhead maintenance boom which can be rotated as much as 400 degrees. Two sets of controls—one on platform, the other may be easily reached from mounting structure. Fork truck or dolly mount. *Emhart Mfg. Co.*

For Manufacturer's Information Circle No. 650, Page 7-8

SERVICING PLATFORM . . . which attaches to fork carriage of lift truck,

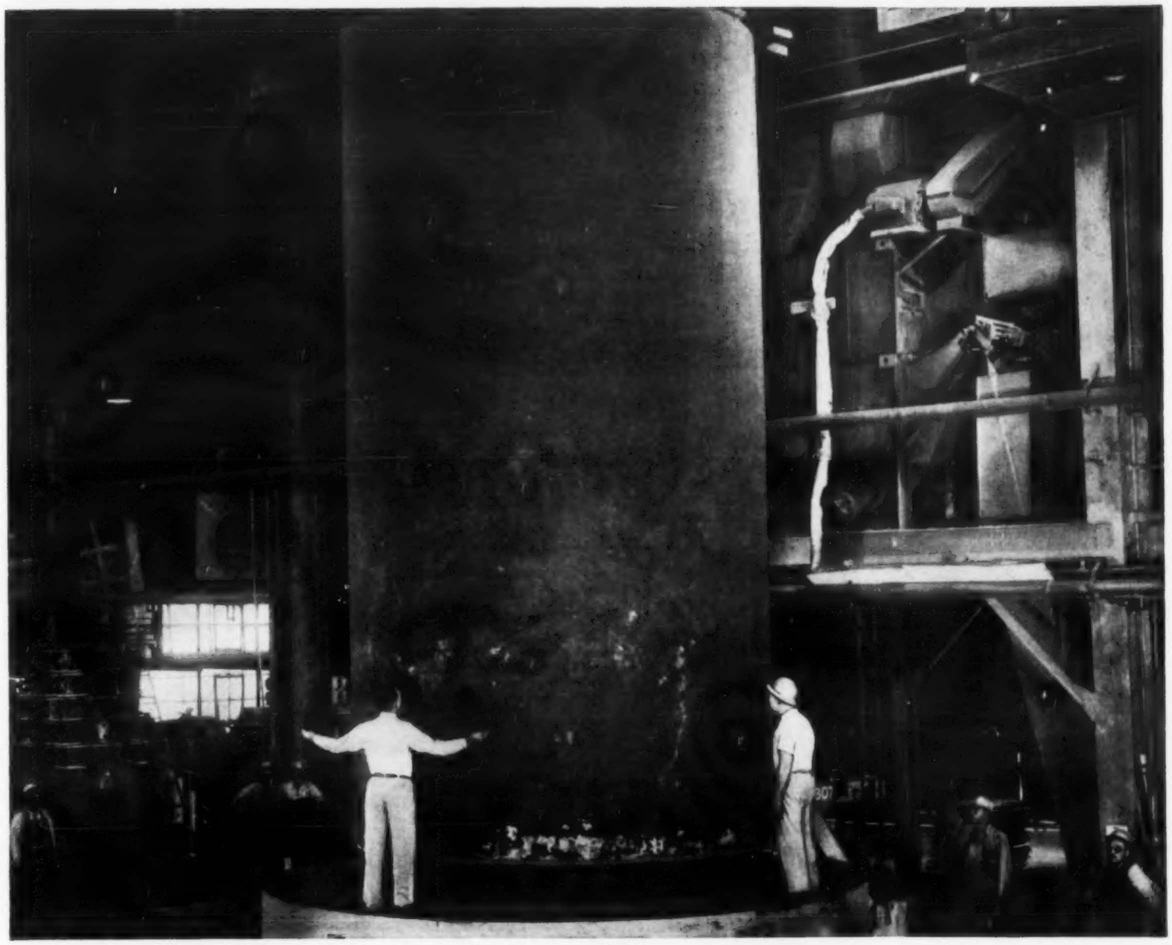


providing 16 sq ft working area. Detachable sides for loading and unloading. Descriptive brochure available. *Yale & Towne Mfg. Co.*

For Manufacturer's Information Circle No. 651, Page 7-8

WET ROOF REPAIRING . . . even during driving rainstorm, according to manufacturer, possible with roof coating. Said to contain highest quality imported and domestic waterproofing oils and high absorption asbestos fibers. Compound reaches through surface dampness, water and snow to revitalize leaky felts. *Monroe Co.*

For Manufacturer's Information Circle No. 652, Page 7-8



40-Ton Dryer Roll being removed from the mold at Newport News Shipbuilding and Dry Dock Company, Newport News, Virginia.

How nickel cast iron helps take the risk out of large castings

Here's a Yankee dryer roll for example. It weighs 40 tons. Length: 262 inches. Diameter: 12 feet.

It's just too big to take a chance. The foundry can't afford a reject. Especially when a reliable metal can assure pressure tightness . . . ample strength . . . a smooth surface . . . and easy machining.

Nickel cast iron assures a sound casting through uniform metal structure

Nickel irons combine fine graphite in a uniform matrix. They promote strength and rigidity, and a surface free of imperfections.

Because of these properties Newport News specifies a nickel cast iron for these rolls. Even with today's high steam pressure this nickel cast iron dryer roll will stay pressure tight. It's definitely not a leaker. Its surface, thanks to nickel cast iron, is uniform and smooth.

The roll easily meets the strength levels required by the boiler code. The basic 1.34% nickel iron composition achieves 40,000 minimum tensile strength every time.

And Newport News needs nickel cast iron to get the high polish, mirror-like finish required on the roll. Uniform structure and the absence of carbides and defects afford a readily machined and polished roll.

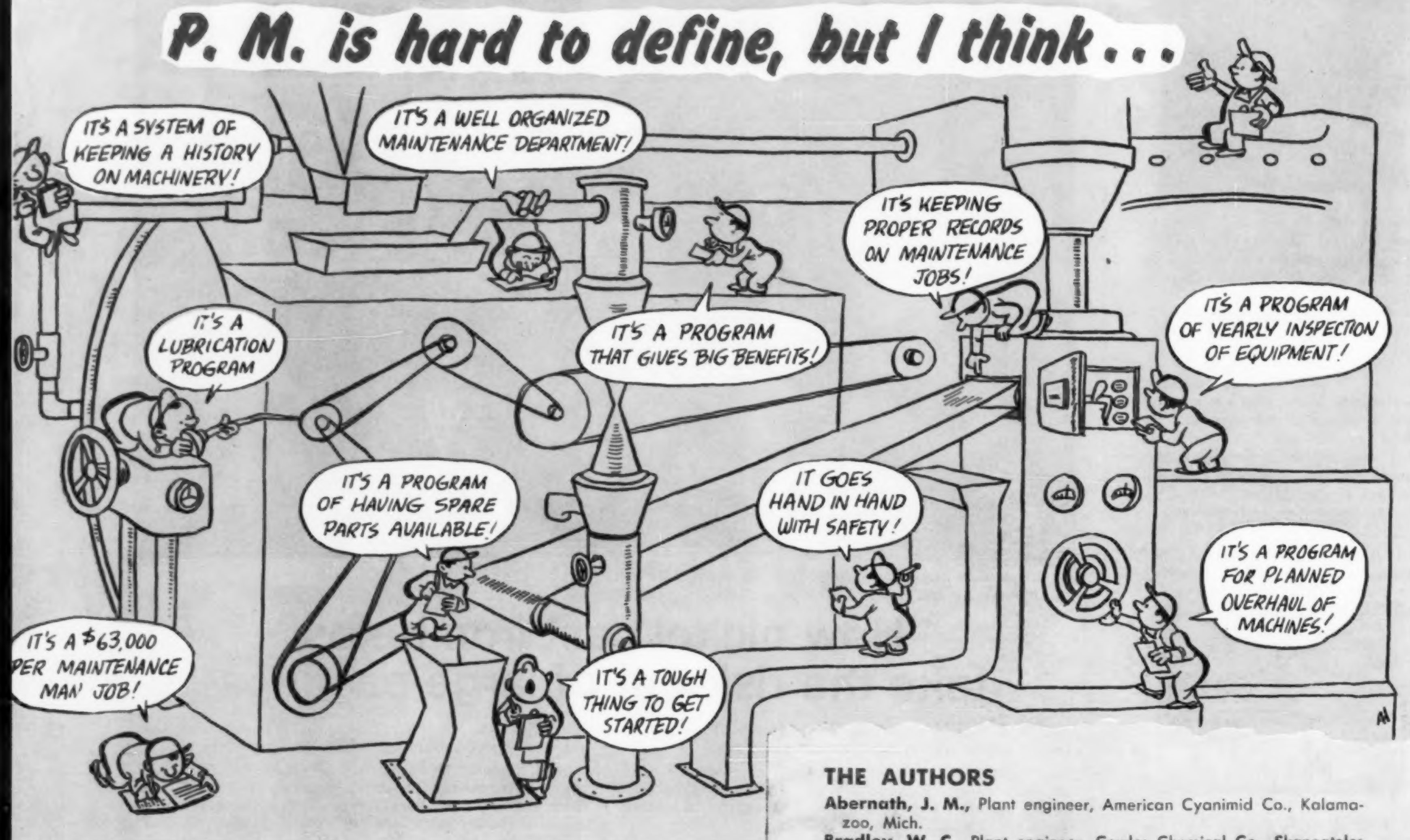
You, too, can get this dependability in heavy iron castings – or in light ones that need high strength, pressure tightness and good machinability. Nickel cast irons are quality castings. And quality castings are good business . . . for you, and for your customer.

For assistance on specific composition problems, contact Inco. Our engineers will gladly provide the metallurgical information you want.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street INCO New York 5, N. Y.

NICKEL CAST IRONS

WHAT IS Preventive Maintenance?



As our little men in this cartoon indicate, a good preventive maintenance program involves many facets, all of which boil down to getting the most service out of your equipment while expending the least amount of money and the least number of man-hours in its maintenance.

Gathered together at the 9th Plant Maintenance & Engineering Show in Chicago last January were men from all over the country whose business is maintenance.

The following paragraphs are excerpts from talks delivered by these experts. They tell you what preventive maintenance is, and how an intelligent program will save you money.

THE AUTHORS

Abernath, J. M., Plant engineer, American Cyanimid Co., Kalamazoo, Mich.

Bradley, W. C., Plant engineer, Cowles Chemical Co., Skaneateles Falls, N.Y.

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Drummond, B. J., Plant engineering department, corporate manufacturing staff, Chrysler Corp., Detroit

Eikrem, Svante, Plant engineer, Hyster Co., Portland, Ore.

Fischer, F. S., General maintenance foreman, Moloney Electric Co., St. Louis, Mo.

Morrow, L. C., Consulting editor, Factory Management & Maintenance, New York

Robichaud, B. J., Maintenance engineer, Toni Co. division, Gillette Co., St. Paul, Minn.

Van Coevering, John, Supervisor, facilities engineering, magnetic materials section, General Electric Co., Edmore, Mich.

Starting a Program

Van Coevering:

How to get started? I believe that we have all probably begun a program. All that is needed is some encouragement to expand

and develop what we now have. In our plant, we have actually begun by doing, and letting the paper work follow. This method has necessitated a simplified program and yet its benefits are helping to sell the advantages of preventive maintenance to our management.

Our program can be summarized as follows: repetitive servicing on a flexible schedule developed and executed by the maintenance foreman, periodic inspections by maintenance foreman and tradesmen on a non-scheduled basis, planned overhaul of equipment as indicated by inspections, routine servicing and records being developed as we go along.

This is a very slow start but it is better than nothing. Also by going slow, I feel there is a better chance to develop a well balanced program without throwing our existing maintenance into a turmoil. I also believe that by going slow, the system itself will help to sell management on a full preventive maintenance program. The cost required to institute a complete program at once would be so prohibitive that we would be defeated before we started.

Fischer:

Start small and grow—if you are meeting with some resistance toward your preventive maintenance program, try it in one particular department, compare motor machinery breakdown frequency with another similar department. Many plants in St. Louis have inaugurated preventive maintenance in this manner.

Probably most of us have been practicing some form of preventive maintenance such as controlled lubrication, cleaning of motors and machinery set-up on a frequency rate or work order blank.

Robichaud:

Check lists can be developed from the following sources of information:

1) Analysis and evaluation of existing instructions and practices.
2) Manufacturers manuals (we had at a prior date obtained manuals for each model of equipment we had).
3) Stockroom spare parts usage records.
4) Machine histories.
5) Talks with manufacturers' servicemen when they were in the plant.
6) Production supervisors' comments.
7) Line adjusters' comments.

Investment Protection

Morrow:

To see how much of the investment in plant and equipment you and each of your maintenance workers is responsible for, on the

average, multiply $6250 by the total of workers in your plant and divide by the number of maintenance workers. Better still divide your actual capital investment for plant and equipment by the number of maintenance workers.

I have found the average figure is $63,662 of plant and equipment per maintenance worker. I submit that the men to whom is entrusted the care of such large investments in buildings and machinery deserve the best in procedures, systems, tools, opportunities and management benefits cooperation.

Benefits of PM

Fischer:

What are the benefits of preventive maintenance? The benefits or values of a productive maintenance program are many, but I would

say the most obvious obtained are the savings to industry on manufacturing costs and the reduction in maintenance costs. These maintenance costs skyrocket when a string-and-chewing-gum type maintenance department is allowed to exist and allows unnecessary breakdowns to occur. A preventive maintenance program is not only beneficial in producing longevity for your machinery and equipment, but insures production schedules will not be interrupted.

Organization

Bradley:

All plants large and small have some common and essential maintenance operations. These can be divided into eight categories:

1) Repair and emergency work. This covers all unscheduled work necessary to correct breakdowns.
2) Preventative maintenance work. This covers the periodic inspection, adjustment, replacement, lubrication, etc., necessary for the proper functioning of the building and equipment.
3) Overhaul. This is a planned operation where the equipment is taken out of service and the necessary work performed on it.
4) Construction work. This covers both addition and new installations of equipment and buildings. If manpower is available, some companies desire to do as much of their own work as possible.
5) Fire protection. This covers regular inspection, testing and correction of defects in the plant fire protection system.
6) Utilities generation and distribution. This covers the operation and maintenance of the boiler room, electric service, air compressors, etc., together with all associated equipment.
7) Mechanical stores. This covers the system by which spare parts and general maintenance materials are kept and replaced. Salvage is also often included under stores.
8) Janitorial service. This may or may not be considered as a function of maintenance.

These are the usual essential operations. You may have more or less, depending on your size and type of operation.

Chandler:

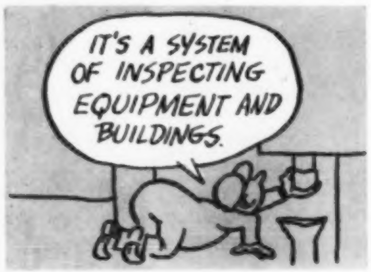
Several years ago, most plants grouped mechanics and foremen by mechanical classifications based on the "tools of the trade". In recent years the so-called area system came into vogue. The "tools of the trade" organization made assignment of total job responsibility impossible and communication demands were difficult to meet. Someone looked at another face of the cube of total maintenance effort and found it divided into manufacturing, service and utility departments. These were separate cost accounting entities and all maintenance jobs were self contained entities within these departments. The area system was conceived from this vantage point. An attempt was made to place a foreman in charge of the maintenance in each department or group of departments.

Problems were encountered in setting up the area system in the plants and many compromises were necessary. Steady work load did

not exist for all of the various classifications of mechanics, many classifications were left in the central groups and dispatched to the area foremen as required.

A third method of grouping is of particular interest. That is, the division of the total effort by classes of equipment which are being maintained. Instrument repair is the classic example. Instrument mechanics are not recognized as a craft in the building trades. They are mechanics trained to maintain instruments. There are few, if any, tools which are peculiar to their trade. The cleavage line is so natural that even the area system did not cross it. Painting, buildings and insulation maintenance also, form natural cleavage lines.

Inspection



Van Coevering:

Another phase of our preventive maintenance program is inspections. This is a very important step but at the present time a separate inspection group has not been created. This is in future plans; therefore, we are operating with a very simplified program.

The maintenance foreman has been trained to spend about 20 per cent of his time on inspection of equipment. As he finds need for repairs he will write his own work orders for his maintenance personnel if the repairs can be performed during normal hours. Of necessity, he must work closely with the production foreman to arrange for repairs during normal idle time. If major repairs are necessary, the maintenance foreman will write an autogram report to the facilities engineer, who in turn will work out an appropriate shutdown with the production group.

As a supplement to this inspection routine, all machine repairmen and electricians are trained to inspect equipment during routine servicing. Any repairs needed are logged in a maintenance log book in the maintenance office. The maintenance foreman will then follow the same procedure as in his own inspections.

Record-keeping

Eikrem:

A complete plant maintenance schedule in itself is not sufficient record-keeping for the successful operation of the program. Other arrangements are necessary, and some of these are as follows:

1) All of our equipment and machinery is numbered for identification. One set of numbers is used for our production tools, and this means of identification is used for production routing and scheduling, accounting purposes and maintenance. Other sets of numbers are used for auxiliary equipment such as air compressors, air tools, heating units and cranes and hoists.
2) Record cards are kept for each piece of equipment, showing cost, date of installation, name-plate data, bearings and parts numbers and other information. Separate cards are kept for motors.
3) Record cards are kept in a file. Each card indicates maintenance frequencies to follow and work to be done, with space for labor time, material involved, repair costs and comments.
4) The cards are arranged in separate groups such as production equipment, electric motors, lubrication lists, air tools, cranes and hoists and so on.
5) The requests for maintenance from various departments are sent to the maintenance supervisor on a maintenance request and report form. This form has a space for the equipment number as well as work to be done or type of fault. The maintenance man doing the work indicates on this form the amount of time spent and the material used. It is then filed for future reference.
6) From the maintenance request form and from the maintenance schedule, the supervisor plans the day's work and issues daily work orders.

Bradley:

We found that some important jobs were not receiving the proper priority and our man power scheduling was very inefficient. We then initiated a modified work order system which functions as follows: Three cards are used, a red one for emergency jobs, a blue one for 24-hour jobs and a white one for general maintenance work requiring no immediate priority.

Cards are initiated by anyone in the plant. A board is mounted outside the maintenance shop on which the three kinds of cards are kept in pockets. A person desiring maintenance work fills out the correct card and then puts it in the proper pocket. The cards are then picked up periodically during the day by the plant engineer, reviewed, approved or disapproved, and assigned a job priority.

Jobs are placed in proper pockets on another board located inside the maintenance shop. No 24-hour jobs are started if there are any outstanding emergency jobs. Likewise no general maintenance jobs are started if there are any 24-hour jobs outstanding. Work requests are placed in the pockets in the order of priority so that the front card is done first, etc. Requests which are questioned or disapproved are discussed with the originator and then either withdrawn or approved.

After the jobs are completed, the cards are signed and placed in the completed card pocket. This system is designed to give more efficient scheduling of our men and to see that jobs are done in the proper order. With any scheduling system, comes paper work. We have purposely avoided all cost estimates, times, etc., on these cards, in order to keep the paper work to a minimum. We pick up maintenance costs on monthly production reports.

Lubrication Program

Van Coevering:

For machine lubrication we have two full time machine oilers. These men have been furnished with a detailed oiling manual which lists each machine in our plant with the types of oil or grease required for each machine.

Since instituting this program, we have reduced by at least 50 per cent the failures due to poor or improper lubrication.

Only by choosing the oilers very carefully can this program succeed with a minimum of supervision. These men must not only show a mechanical aptitude but must be very conscientious.

Eikrem:

We analyzed the lubrication specifications of the machinery manufacturers, matched them with the products of four major oil companies, classified these lubricants according to a color code and reduced the varieties on hand from forty to nine. We also built an oil storage building, assigned a man to take charge of lubrication, and reduced not only the cost of lubricants, but also the labor time.

Abernathy:

Several years ago we asked one of the major oil companies to send in a lubricating engineer. He made a complete survey of our equipment and made recommendations as to the frequency and type of lubrication to be used, which we have followed. When new equipment is added, or trouble develops, we consult with them.

Spare Parts Program

Abernathy:

To start a spare parts program, hire a young man with drafting experience. Then make him a store room clerk, responsible for maintenance stores inventory and for distribution, supplier equipment files, the equipment record book and a monthly statement of the individual equipment repair cost. Repair parts for each job would be requisitioned from stores and charged to the job they were used on.

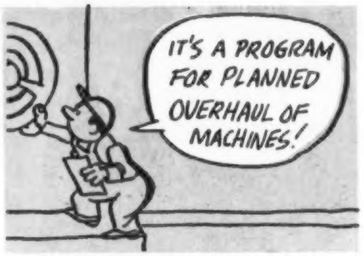
He would also do necessary drawing required by the plant engineer. Since our plant is little, we would also use him as a production clerk, maintaining inventory records of raw and finished materials, production batch sheets and planning schedules.

Bradley:

The type of operation largely determines how much detail should be given to the maintenance stores. A very simple system may suffice where the total number of items is small, the dollar investment is low and stock outage not serious. As these increase in number and value, more rigid controls are needed. With ten or fewer maintenance men, I have not been able to justify a clerk for this operation. However, even with little formal control, certain minimum conditions should be met:

1) Have a central storage area designated for spare parts only.
2) Have access limited only to authorized personnel.
3) Have some method of storing items by department, machine, category, etc.
4) Have some method of recording items removed from stock.
5) Stock critical items after balancing costs against downtime.
6) Take a physical inventory at least once a year.

Planned Overhaul



Van Coevering:

A third phase of our program is planned overhaul. Since the plant is relatively small we do not have the facilities for extensive overhaul of the larger equipment. Therefore, as routine maintenance and inspections indicate that the condition of the equipment requires a major overhaul, the maintenance foreman will notify the facilities engineer, who in turn works with the manager-manufacturing-engineering and the production departments to schedule a downtime of sufficient length of time to have the overhaul job done by an experienced machinery rebuilder.

The process engineer and the production foreman is then also consulted and if necessary, temporary repairs are made to keep the equipment operating until an opportune time for a shutdown.

Yearly Inspection

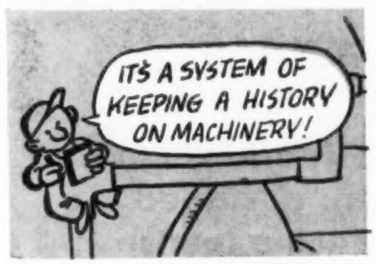
Van Coevering:

During the normal plant vacation shutdown, yearly inspections are made of all facilities equipment.

During the year, the maintenance foreman and the facilities engineer keep a log of conditions which inspections indicate should be checked. This log also includes those items which need repair but could be delayed until vacation shutdown. Also listed are the items which have been temporarily repaired to keep them in operation.

About a month in advance of vacation shutdown, the facilities engineer and the maintenance foreman will analyze this log and schedule the work. Where the work load is too great for plant personnel or where special skills are needed, contractors are called in and arrangements are made to have them work with the maintenance crew during the plant vacation shutdown. Again, a minimum record system is used to reduce paper work; and yet the necessary preventive maintenance work is accomplished.

Machine History



Van Coevering:

A fourth and very important part of any preventive maintenance program is the machine records. I believe that these should not only be a machine rating or spare parts record but also a maintenance history record. So often the usage of the machine will determine the serious wear parts. The machine maintenance record will immediately indicate the inspection points and also the spare parts to keep in inventory. In addition this record will quickly reveal if a particular machine is correctly applied for a particular job.

It can also be used when planning new facilities pointing out pieces of equipment with high maintenance costs. This is the part of preventive maintenance which seems impossible and takes the greatest time to set up. It is expected that this part of our program will take several years as we are accumulating the necessary information with existing personnel. Once these records are set up, they will be simple to maintain.

Fischer:

Machine history is an important phase of the preventive maintenance program and accumulating this information incurs time and money. We began by numbering all the machinery in our core cutting department and setting up a card system bearing the number and description of each machine and its components. Information kept on these cards tells us when we should reorder stock and parts, what sort of major and minor repairs are being made and if the same type of trouble is recurring frequently on any one machine.

Safety Benefits

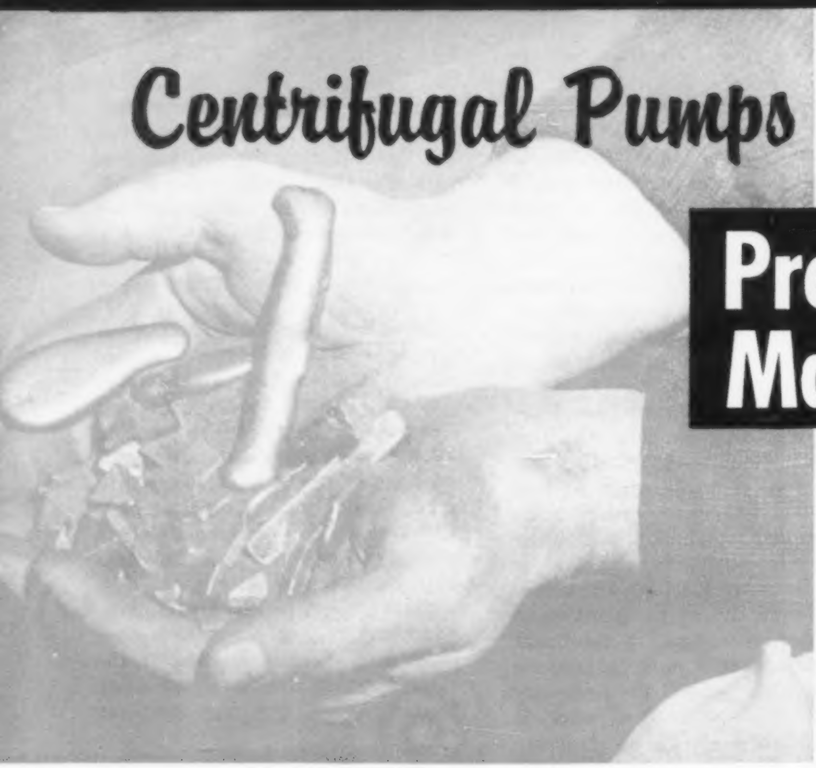
Drummond:

Maintenance and safety go hand in hand. A poorly maintained machine will often be distinguished by its erratic behavior.

The shop with a well planned maintenance activity will frequently be distinguished by a low frequency rate of industrial accidents.

The safety engineer in an automated plant has a very important job to do. His problem is not only a matter of preservation of flesh and blood, although this is certainly the most important consideration, but to develop a safety program which will reduce the lost time accidents and lower workmen's compensation costs. His job can earn a reputation not only for the plant involved, but for the company, as a safe place to work; and can keep the potential available work force high.

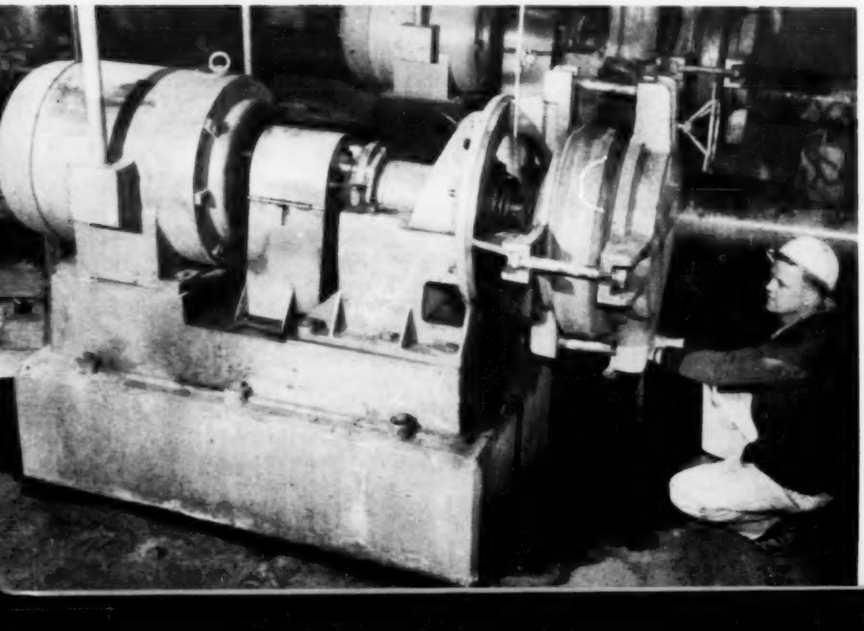
Centrifugal Pumps Prime Preventive Maintenance



Sand and metal may constitute 50 per cent of slurries moved by sand reclaimation system.

Pumps are key to auto foundry's sand reclamation system designed for minimum maintenance expense

Pumps operate 16 hours per day, 5 days weekly need service only at 6 month or one year intervals.



ROBERT E. JACOBY / *Chief Engineer*
Morris Machine Works
Baldwinsville, N.Y.

1600 tons of highly abrasive solids are being moved daily through a sand reclamation system designed to minimize maintenance costs.

The system, installed in a Western New York automotive foundry, utilizes centrifugal pumps for which the service life of each component has been accurately determined. As a result of this study, pumps can be removed from service ten days before the end of the estimated service period. Thus, the system is removed from service at the convenience of the foundry and spare pumps are placed in the system while the replaced units are rebuilt.

Production of gray iron automotive castings, varying from engine blocks to bearing caps, requires high-quality sand at this large automotive foundry. Sand comprises 85-90 per cent of the waste material derived from molds and cores; the remainder being clay, sea coal, cast iron chunks, and other sintered material ranging from 6 to 200 mesh in size.

Following its use in mold and core making, such sand might be discarded as waste were it not for the efficient reclamation system. Two main objectives of the system are to 1) reduce quantity of sand purchased; 2) decrease amount of sand discharged as waste. Through reclamation, used sand is classified, washed, reclassified, screened and dried before re-use.

Sand Reclamation Cycle

During foundry operation, molding department sweepings, sands from casting "carry-out" and dust collectors are fed into a single pit and mixed together in water. The slurry is then discharged by two centrifugal pumps, at 155 ft it heads through 2200 ft. of piping at 1200 gpm to the hydraulic abrasive blasting building. From the pit an average of 35 per cent solids by weight is pumped—occasionally as high as 50 per cent. It is estimated that in a year's time these pumps handle more than 150,000 tons of highly abrasive solids.

Hydraulic Abrasive Recovery

In the hydraulic abrasive blasting area, 600 gpm of outside water is added prior to the cleansing process. In a 160-ton primary classifier fines are floated off the top

of the tank and, together with surplus water, moved by centrifugal pumps at 1320 gpm to two settling tanks. The remaining slurry from the primary classifier flows by gravity to two scrubbing tanks, 4 ft in diameter and 6 ft deep, where an electrically-driven agitator scrubs the sand. Slurry then moves from scrubbers to a 3 x 8 x 2-ft deep rectangular tank. Floatable material is washed over a weir at one end of the tank to join the slurry of fines from the primary classifier.

Heavier material flows out adjustable orifices in eight spigots through which counter-flow water is passed. Adjustment of the counter-flow water volume and spigot apertures control grain size of sand particles flowing through.

Slurry from the receiving tank under the spigots is pumped to a circular filter table. A vacuum is drawn below the screen bottom of the table. The water is forced through the screen and pumped to the sludge tanks.

Sand remaining on the filter table contains 7 to 8 per cent water and is removed from the table by screw conveyor to a rotating, cylindrical, oil-fired drier. Sand falls from the drier to a similar cylindrical cooler. Air is drawn through the cooler counter to the flow of sand and exhausted to a dust collector.

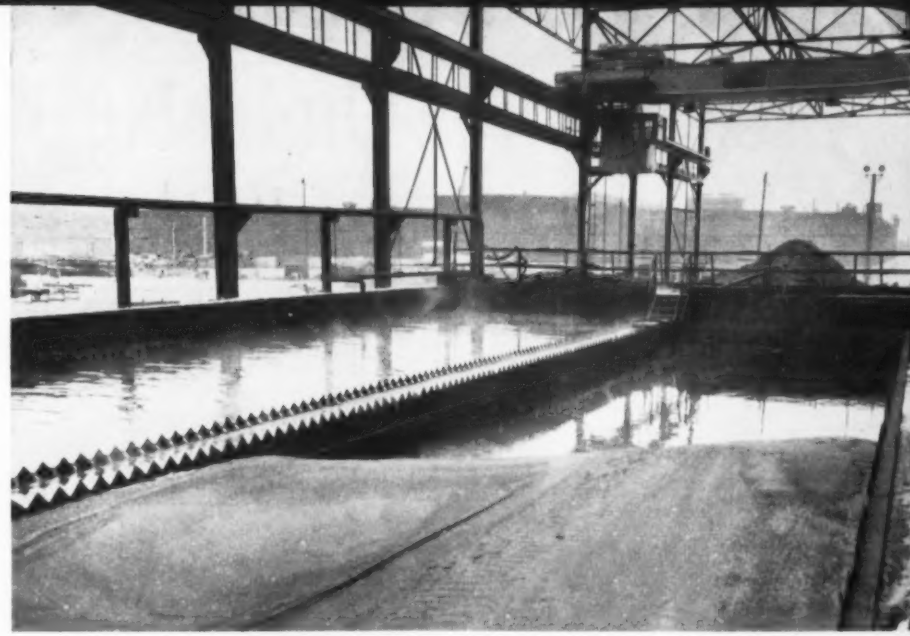
Cooled sand falls into a vibrating pan screen 14 in. wide and 25 ft long. Reusable sand drops through the screen to the pan and goes into a bucket elevator to a storage bin. An inclined belt conveyor under the bin conveys sand to a second bucket elevator which delivers the reclaimed sand to core room mixers.

Slurry from receiving tanks is pumped to circular filter table where operator is measuring sand cake.

Settling Tanks

Slurry is pumped into each of the 225,000-gallon settling tanks alternately, where it remains for approximately one hour, the effluent flowing, by gravity, to system's redistribution well. While in the settling tanks, solids in suspension settle to the bottom and are removed by clam-shell bucket and loaded in trucks for disposal. As water flows from one tank, the other remains undisturbed to allow settling action to take place.

The redistribution well receives water from settling tanks at about 1800 gpm. Of this water, 1200 gpm is recirculated without treatment in a closed system back through the foundry. Six hundred gpm flows into a 225,000-gallon clarifier, retained for approximately 7 hours and treated with alum and lime. The water is then returned to a nearby river through waste outlets; less than 50 parts per million of solid material is present upon discharge. Untreated recirculated water is fed by two centrifugal pumps at 125 ft head through 10-in. piping back to the foundry area to continue the sand reclamation cycle.



Primary settling basins hold slurry for one hour. Water is pumped out and solids removed by bucket.

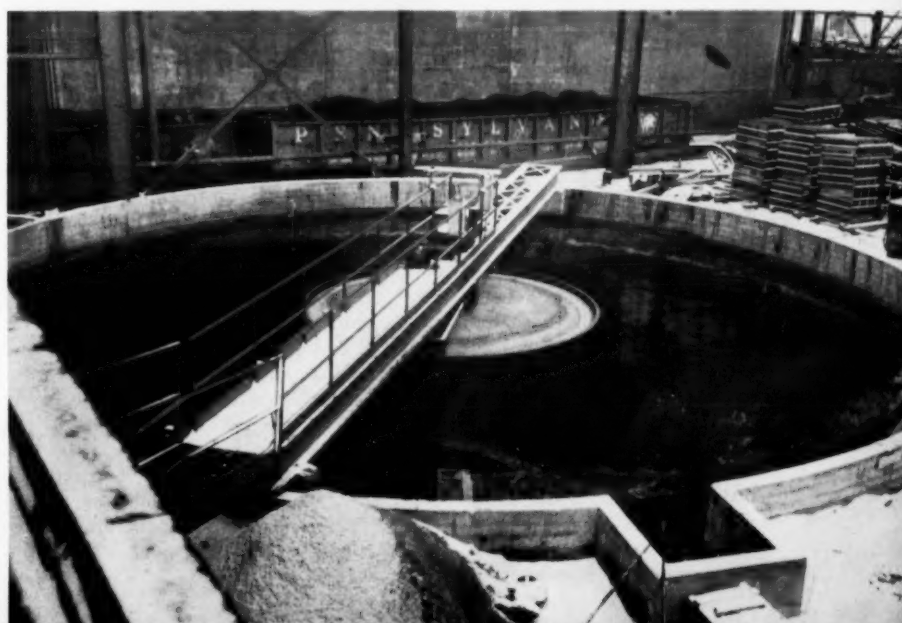
Maintenance

The pumps employed in this system are designed so that little shaft and/or bearing maintenance is necessary. Such maintenance would require that the entire pump be torn down and reassembled. Parts normally requiring maintenance are the impeller, suction disc-liner and shaft sleeve.

Service life of these components has been determined and noted in the maintenance department's 6 to 12 month log on part wear so that the pump may be removed from service immediately preceeding the end of the service-life period.

■ To obtain single additional copies of this article, circle B, Reader Service Card, page 7-8.

Waste water flows to clarifier for treatment prior to discharge into sewer or return to sand system.



Memo to the Industry

Subject: Saving Through Preventive Maintenance

Location: Chicago Hardware Foundry Co.

Reg Harland, maintenance supervisor, is filling out a work-order to post on the maintenance schedule board.

S. A. Simonson /
Plant Engineer
The Chicago Hardware Foundry Co.
North Chicago, Ill.

As plant engineer of The Chicago Hardware Foundry Co., Mr. Simonson has a first hand familiarity with all the problems of foundry maintenance. Leadership in his profession has been given recognition by his recent election to the position of national president of the American Institute of Plant Engineers.

Keep it clean, and if it moves, lubricate it.

This credo is as basic to the foundry maintenance engineer as the old saw, 'If it moves, salute it; if it doesn't, paint it,' is to the GI.

A good description of a basic, low-cost maintenance program is contained in that capsule statement. Unfortunately, the increasing complexity of production equipment in the metalcastings industry has also complicated the problems of maintenance.

The basic problem, however, is still how to get the most service from a machine while spending the least possible amount for maintenance. This article will describe some of the answers that we have found at Chicago Hardware Foundry Co., and have incorporated into our maintenance program.

The degree of mechanization and automation varies with the size of the plant and its product, but we all know that our maintenance problem is becoming more complex as we install this new equipment. A description of the Chicago Hardware plant will enable the reader to compare his plant and problems with the problems we have met.

Chicago Hardware Foundry Co. produces gray iron, brass and aluminum castings that vary in weight from less than a pound to several hundred pounds. In addition, we have a manufacturing division which includes a machine shop, porcelain-enameling plant and a plating department. With this setup we can give the customer a finished casting if he so desires. All maintenance is under the Plant Engineering Department. The maintenance divisions are Mechanical, which includes tinshop and pipe shop; Electrical; Carpentry and Yard, which includes janitor service. The total number of employees in the maintenance divisions is forty. Total employment in the foundry division is approximately 250, plant employment, about 600.

Scheduling

Scheduling of maintenance work is done from the main maintenance shop. All orders, written and phoned, are given to the job dispatcher who has job tickets made out and posted on the scheduling board. The maintenance foremen work with the dispatcher from the scheduling board and line up the work from day to day, deciding the sequence in which the jobs are to be done.

Workmen are given copies of the job tickets and go to the various departments and perform the work. The worker contacts the production foreman upon arrival in his department. The foreman signs the work ticket when the job is completed to his satisfaction. This practice acquaints the department head with the maintenance work being done in his department so

when he gets his monthly budget sheet, he can't say he is charged with excessive maintenance costs.

We have area mechanics located full-time in the molding departments and the casting departments. They report to the dispatcher at the start and finish of their shift; their work is not scheduled and much of it is done at the request of the supervisors of these areas in which the men are stationed.

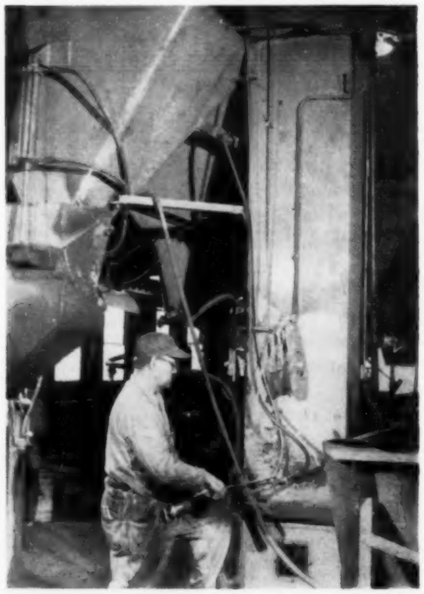
Inspections

A differentiation should be made between inspection of equipment and the casual observation of this equipment in operation. Almost every machine used in the plant, every day, gets some attention from someone during its operation. This may be the machine operator, the department supervisor or a maintenance man. Such observations cannot be called inspections although they prove beneficial in preventing breakdowns.

We do not have any men who are classified strictly as inspectors. This function is performed by the maintenance foremen, the area mechanics, the lubrication man, production department foreman and the key men in some departments.

Inspections made by capable men who know the internal working of the machine are, of course, the most valuable in preventive maintenance. We try to utilize men for this work who have worked on or observed the disassembly and reassembly of the equipment they check. It is a good idea to have the lubrication man work with your mechanics on some of the Saturday repair jobs to learn this.

Ted Loehrke shoots grease to overhead bearings via plastic tubing.



The frequency of inspections is governed by three factors: one, the importance of the equipment; two, the hours of operation per day; three, the type of equipment.

For example, the cupola, with its blower and charging equipment, must receive close inspection daily. In our plant, the lead man of the charging crew serves as inspector of the charging equipment, checking cables, controls, monorail switches, etc. He reports any sign of danger to the maintenance dispatcher. The blowers are checked by the lubrication man.

The molten metal carrying equipment also must receive rigid inspection daily. This is necessary, not only from a production standpoint, but also for the safety of the employees handling the metal. The metal dispatcher in the cupola department and the maintenance foreman make this inspection.

Another important unit is the main sand conditioning department. We condition about 75 per cent of the sand used in all the foundries with this one unit, its shut-down stops almost all molding operations. In this unit, there are belt and apron-conveyors, belt elevators, shakeout machines, sand mixers and a pneumatic sand conveying system which carries the sand to seven stations.

The operator of the pneumatic system, which is push button controlled, inspects the solenoid-valves, cylinders, switches, bindicators, etc., in his unit. The lubrication man from the main shop serves as inspector of the other equipment when he makes his daily rounds with an assist from the molding department mechanic at times.

The inspection of molding machines is done by the mechanics stationed in the section when they mount patterns and lubricate the machines. This is a daily job.

The molding sand mullers are checked daily when they are being lubricated by the lube man. This man spends all his time traveling thruout the plant and serves as the inspector of the other miscellaneous equipment.

The mechanics stationed in the casting cleaning departments inspect the blast equipment daily.

Frequency of equipment inspection is also governed by the hours per day and operating conditions. For example, sand mullers in molding and facing sand systems must be inspected daily while the same type of machine in core and shell molding departments require inspection twice a week.

Maintenance Problems

The basic problem in equipment maintenance is how to get the most service from a machine with the least amount of maintenance.

Henry Hangebrauck holds quick-connect couplings for sand conveyor.

Should a machine be taken out of service for a complete overhaul after it has operated a stated number of hours, or should it be operated until it shows signs of distress? The high cost of repair parts makes the maintenance man hesitate to take a machine out of service while it is operating to satisfaction, although records show it is time for an overhaul. The ideal arrangement, of course, is to have a spare unit on hand to install while rebuilding the worn unit in the shop. Again, the high cost of this spare unit in many cases does not make the idea acceptable to management.

Ralph Gunter checks 6 cams and 7 switches on shell molding machine.

We have set up a new repair schedule for our shakeouts and screens. These machines get some very hard use and are generally almost buried in sand. The shakeout men are not very careful to set the poured mold properly on the deck and the sand spills over the sides. Once a year before vacation shutdown a thorough inspection is made of these machines by a factory service man and the necessary parts ordered. These service men can tell by the sound of the machine what parts are required and always recommend a few extra parts. The repairs are made during vacation and the machine is good for another year with only minor repairs.

One cause of excessive wear in the bearings of these machines is an unbalanced eccentric shaft. When the machine is built at the factory this shaft is balanced with the deck weight. After the machine is in use for awhile this deck gets worn and pieces of steel are welded to it, in some cases higher sides are found necessary and as a result the shaft is running in an unbalanced condition. We have also found that the speed of this shaft can be reduced without effecting the efficiency of the machine. This will give longer life to the bearings. We use grease in the bearings of our small shakeouts and have an oil system on the larger one.

On our belt elevator head and foot pulleys we use a solid bronze bearing which gives a longer life than anti-friction bearings former-

Electric oil pump is used to protect two bearings on shakeout machine.

ly used. On the bearings located in pits a plastic tubing runs to the bearing from a large oil feeder located above the floor. The big problem is keeping sand away from the bearings and keeping the pits clean. This chore is done by the night foundry crew.

Apron conveyors are costly from a maintenance standpoint and we schedule the complete replacement of wheels, bushings and rods about every six months.

Horizontal and inclined belt conveyors give the least amount of trouble. Of course, when a sharp piece of scrap gets wedged between the belt and hopper plate and cuts a long slot in the belt before it can be stopped, it generally means a new section of belt and this is a very costly item. Using rubber belt with wire inserts every three feet will prevent a long cut.

Several years ago we installed a pneumatic sand conveying system. We wanted to distribute sand to molder stations quite a distance apart and not in line, so the layout was not suitable for belt installation. In the original installation short radius curves were put in from the transporter and sand stoppage in these pipes was serious. To eliminate this trouble we had to revamp the layout and install long radius curves. Replacement of the pipe is the big item in the maintenance of this system.

Bearings on sand elevator get oil from reservoirs via plastic tubing.

Abrasive action of sand at high velocity wears out the pipes in several months' time. We have tried ni-resist cast curves but it is difficult to get these to fit properly and there is danger of breaking flanges if the alignment is not right. We now use a clamp-type joint which makes the replacement of the sections of pipe easier than the bolted flanges formerly used. The switches in the system use rubber hoses which wear out at the moving end. Solenoid valves, relays and switches in the control require very little maintenance.

The key to long life of wearing parts in sand mullers is keeping it clean. If sand is allowed to build up in the crib it soon gets like concrete and wears out the plows very quickly. These plows, with their hard-faced edges, will wear out in a few months under such conditions. Mulling wheels in these machines operate in sand all the time and if bearing seals are not kept in good condition, sand gets into bearings. Bearing replacement is quite a job as the wheels must be taken out of the machine.

Molding machine maintenance is not much of a problem in our operation. The mechanics stationed in the molding areas are experts on these machines. The machines are lubricated daily, kept clean and the sand is not allowed to accumulate around the machines. Of course the machines wear out and must be repaired. In the case of the smaller machines we have spares to use when necessary. Larger, stationary machines must be repaired in the foundry. Replacement of worn piston leathers or rings can be done over the week end, but major repairs must be scheduled for the vacation period or production schedules arranged so the machine can be taken out of service.

Reducing maintenance costs on grit and shot blast equipment is a big problem. The manufacturers of this equipment are striving to get materials that will give longer life to the wearing parts and they are making progress. The cost of these parts is many times the cost of regular parts formerly

Special fitting in air line has wire strainer to catch all solids.

furnished and they must give many times the service to pay for themselves. The operator of this type of machine can do much to keep maintenance costs down. To prevent excessive table wear, he should keep the tables covered with castings. He should detect any unusual noises indicating bearing wear in the shot wheels, should notice any excessive wear in the lining and should see that the exhaust system is working properly so that dust is not being carried back to the wheel. You might say a man of this calibre doesn't belong on a blast machine, but we have both good and bad operators, and the maintenance costs of the machines show the difference.

Several machines use the same blast wheel and we keep in stock a complete wheel assembly of wheel, shaft and pillow blocks.

Spare Parts Stores

We tag each part as it is received. On this tag is written a complete description of the part, what machine it is for and ordering data. When this part is taken out of the stockroom this tag is removed and notation made on the card system which shows the inventory of this item; the clerk knows whether or not to re-order.

Lubrication

Lubrication of foundry equipment can become rather involved but the fewer kinds of lubricants used, the better. When to use grease is sometimes a problem, and also how often to lubricate the bearings. The manufacturers of the equipment can give answers to many of these questions but many times you have to learn by experience, as your conditions may be a little different.

We use a regular Alemite grease for our general run of bearings, and a special temperature grease for the bearings of the fans on our core ovens which are handling 600 to 800 F air. In the oils, a light machine oil is used for general lubrication, and a 40 SAE oil in our cupola blower bearings. To lubricate the piston leathers in the cylinders of the molding machines we use a fish sperm oil. Pneumatic tools such as rammers, chippers and grinders are lubricated with a light oil made for the purpose.

Building Maintenance

Building maintenance problems in the metalcastings industry, as far as the exterior of the buildings are concerned—is similar to that of other industries. Fly ash may accumulate on the roof adjacent to the cupolas, and sparks from this source might burn some holes in the roof or lodge in some crevice and develop into a fire, but most problems are inside the building.

Concrete floors in the foundry get rough usage; hot metal spillage causes spalling, and portable jolt machines cause the floor to crack. If we knew just where these machines were to be located, the floor could be reinforced to take the load. When a machine is located in a permanent spot, for example under a hopper, steel or cast plates are set in the floor. In the chipping rooms where castings are dropped on the floor we use a hex steel grating which is grouted into the floor. Heavy traffic aisles have steel floor plates. For the repairing of small holes and worn spots we use mastic flooring material.

The doors in our buildings keep the carpentry department busy. We use front-end loaders and fork trucks, and some drivers raise havoc with the doors.

Results

Intensive maintenance efforts during the past two years have paid off with substantial curtailment in production delays and an over-all reduction of one-third in the annual cost of maintaining foundry equipment.

■ To obtain single additional tear sheets of this article, circle C, Reader Service Card, page 7-8.

LES WITTMAYER /
Maintenance Leadman
Electric Steel Foundry Co.
Portland, Ore.

Memo to the Industry

Subject: Saving Through Preventive Maintenance

Location: Electric Steel Foundry Co.

You've all experienced the frustration of having to hold up a good percentage of your production facilities while maintenance personnel frantically went to work on one machine that had ceased to operate. Chances are the trouble originated from the malfunction of a small, inexpensive part; had it been replaced *before* it failed, many hours of down-time would have been saved.

You don't have to be psychic to know when to replace a wearing part, but you do have to know what to look for. During the past year, Electric Steel Foundry Co.'s Maintenance Department has inaugurated a preventive maintenance program. Through inspection, it is the maintenance man's responsibility to determine whether a wearing part will last until the next inspection period.

Maintenance personnel are instructed to consider:

1) How will a breakdown during production hours affect other production?

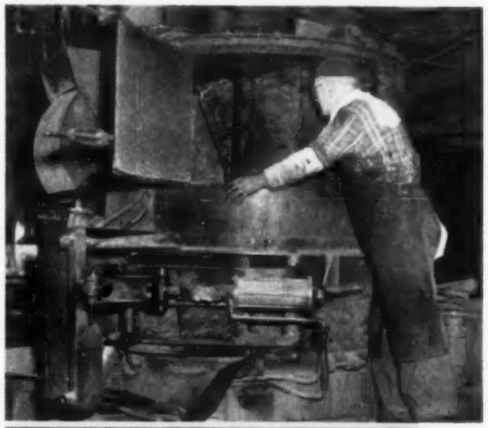
2) How long will the replacement take?

3) What is the cost of the part to be changed?

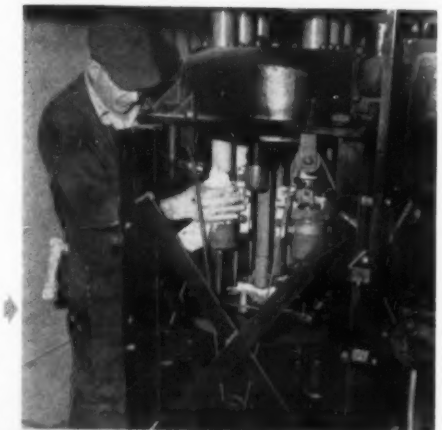
4) What will be the cost in lost production?

Records must be kept to determine and evaluate maintenance costs. Foremen of various departments issue work orders for inspection of their equipment, which is done during idle periods. Each man in the maintenance department fills out a card detailing the machine, department and time spent on the job. From these records, a part which has a known period of operation can be replaced before it fails.

■ To obtain single additional copies of this article circle D, Reader Service card, page 7-8.



Sand muller receives periodic inspection, lubricating, cleaning.



One of four 11,000-volt oil switches for furnaces inspected on a two-week program.

Servicing controllers on 20-ton crane; they are checked and lubricated daily at noon.

Jack shaft on stand grinder in cleaning room is checked daily, repaired on week end.

Oil line is changed on spinning machine. Lubrication important because of high rpm.

Sanding rough spots off squeeze machine cylinder increases service life of the piston.

Memo to the Industry

Subject: Saving Through Preventive Maintenance

Location: Stanton Iron Works Co., Ltd.

J. I. Blackbourn /
Chief Works Maintenance Engineer
Stanton Iron Works Co. Ltd.
Nottingham, England

The definition of the word maintenance is briefly, 'to keep in order, proper condition or repair.' The words 'to keep in order' should be stressed, as far too many people regard maintenance as putting something right when it has gone wrong.

The right time for maintenance is before trouble develops and, if items of equipment and plant are not well maintained, some irregularity in the process occurs and production suffers. The irregularity may take the form of a breakdown, stoppage or perhaps an accident.

Whatever form it may take, both the production personnel and engineers are soon in trouble. But the main point is that production suffers, and the value of true maintenance or care, which is continuity of output, is lost.

While one aims at keeping plant and equipment in proper order, it should be remembered foundries are competitive concerns and must therefore aim at keeping order in the most economical manner.

The term 'plant and equipment' embraces everything concerned with the production of the end product, not only the obvious items such as cupolas and molding machines, but also buildings, railroads and mobile equipment.

Maintenance is made necessary by a wide variety of factors that can be classified under the following five general headings:

- *Fair wear and tear*
- *Neglect*
- *Faulty operation*
- *Premature failure*
- *Accidental damage.*

Fair wear and tear—Even with the best upkeep and care, there is bound to be certain wear and deterioration which will eventually render the equipment useless for further efficient service until maintenance is carried out. The frequency with which attention is necessary varies considerably for different types of equipment. To take extreme cases, the rams on a hydraulic pump can be expected to run for a year or two before requiring skimming, whereas the shot impeller on an airless abrasive blast-cleaning machine may have to be changed after only a few hours' service.

Fair wear and tear is generally the least of the causes of maintenance and is most easily dealt with as it can be anticipated and dealt with in a routine manner.

Neglect—There are innumerable ways in which plant and equipment can be neglected. So far as machinery is concerned, the main item of neglect is lack of lubrication. If moving parts are not properly lubricated, friction develops and the life of the machine is cut down considerably.

> **FROM: British Foundrymen**
> **TO: AFS Foundrymen**
>
> This article marks the beginning of an exchange of articles between MODERN CASTINGS, official publication of the American Foundrymen's Society, and THE BRITISH FOUNDRYMAN, official organ of the Institute of British Foundrymen.
>
> This first article is abridged from the paper published in the April, BRITISH FOUNDRYMAN and presented at the annual meeting of IBF in May, 1958.

Another item of neglect is lack of cleanliness. It is no exaggeration to say that 50 per cent of maintenance troubles arise from dirt; in most cases, unnecessary dirt. Foundries are not easy to keep clean but there is no need for equipment to become filthy. Many equipment breakdowns are due primarily to bearing failures not caused by overload or lack of lubrication, but by dirt.

Another aspect apart from maintenance, which might well be mentioned here, is that if equipment in a department is allowed to get into bad shape the men will be quick to seize on it as an alibi for bad work, claiming allowances.

Faulty operation—Faulty operation is often the source of an engineer's biggest difficulties. Whether it is deliberate, accidental or negligent, it is impossible to eliminate completely; as it is caused by the human element, an unknown factor. For example, a man who is normally conscientious and skilled in his job may one day make a mistake that ruins his machine and stops production. Subsequently, it may be found that he has outside worries or is not well. Whatever the cause, the result is generally an emergency job for the maintenance department.

Comprehensive instructions must

be given to the operator and whoever issues these must be quite sure that such instructions are thoroughly understood. A man's assurance that he understands is not sufficient; he should always be made to demonstrate his duties.

Examples of faulty operation that must be prevented are: the operator who works his pneumatic grinder or hammer for a longer period between cleaning and oiling than that laid down by the maintenance department; or the man who pushes scrap through the knockout on to the return sand belt hoping that the magnetic separator will do his job for him, probably resulting in a cut belt.

Abuse of equipment is not always due to lack of care by the operator. Very often, especially in jobbing foundries, it is because work put into the shop overloads certain items of plant and causes breakdowns. For example, the crane in the casting shop may be rated at 15 tons lifting capacity, while the crane in the cleaning department is capable of lifting only 7 tons. If the latter crane is used to turn over 15-ton castings, trouble will occur.

Premature failure – Premature failure can also be a source of difficulty as it is unpredictable. However, as failures of this nature are generally due to faulty design or faulty material, they can be largely prevented by using only proven equipment of reliable manufacture.

Accidental damage—This is generally due to outside forces such as storms, fire, etc. Apart from taking all sensible precautions, there is no control over this type of damage.

Dealing with Maintenance

Since it has been decided what necessitates maintenance and the aims of good maintenance have been defined as keeping equipment in order and reducing to a minimum the incidence of breakdown, the methods of dealing with the causes can now be examined. The causes of maintenance and the method of dealing with each may be summarized as follows:

Fair wear and tear—This is the only cause which, theoretically, can be dealt with by planned maintenance, the fundamental aim of which should be to give the minimum of service at the longest possible intervals, consistent with trouble-free operation.

Neglect and faulty operation—These items can, to some extent, be intelligently anticipated and planned.

Premature failure and accidental damage—These items are unexpected and can only be dealt with as they arise.

Maintenance at the author's company is conducted on a basis designed to give maximum plant availability and safety at minimum cost. This is achieved by regular routine inspections of certain plant and equipment and by planning preventive maintenance as a result of these inspections.

To define the type of equipment upon which routine inspection and maintenance are carried out would be extremely difficult, but generally it is carried out on any item when it can be shown to be more economical than casual maintenance or when it is necessary for safety reasons. It is realized that the cost of routine examinations can be high, but it is also realized that small defects in a machine, if ignored, can quickly cause major defects and can cause the quality of the product to drop and output to be held up, with all the resultant implications.

Certain items are left for periods to be reported on by production men or perhaps greasers or other maintenance men without any form of planned inspection. Other items are maintained by thorough inspections and overhauls after long intervals, relying on the operator to report any wear or faults between overhauls.

Over-all maintenance can be divided into four general groups:

- *Regular routine inspection and preventive maintenance work*
- *Periodic major overhauls*
- *Preparation of spares*
- *Breakdown or emergencies*

Regular routine inspections—Efficiently conducted routine inspections are of paramount importance to the system of planned maintenance. When it has been decided to plan a maintenance schedule for a particular item, the item must be considered most carefully to ensure that the best form of inspection is evolved. The frequency with which inspections must be made and the exact details of the inspection will probably have to be worked out in practice, as one can afford neither too frequent nor too few inspections.

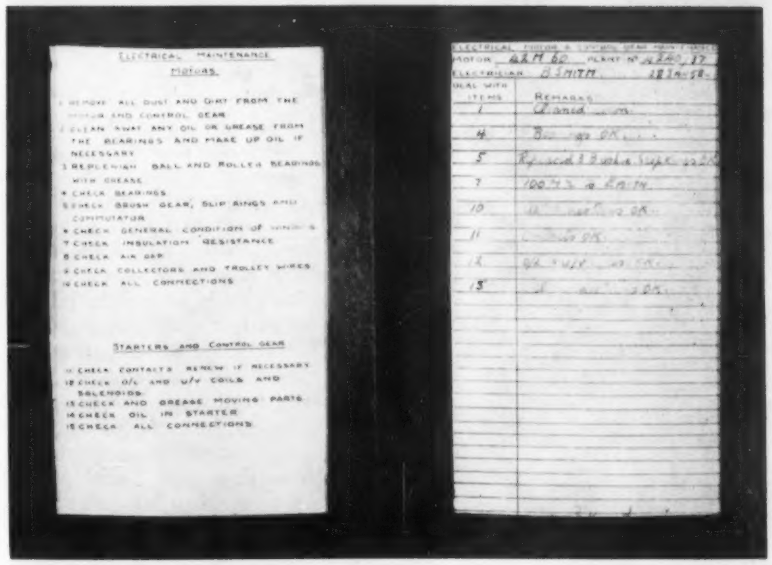


Fig. 1 . . Inspector's aid includes check list and report.

Figure 1 shows one type of inspection system in use. The man making the inspection is given a folder, on the left-hand side of which is a card showing details of the items to be inspected and on the right-hand side a report card which is filled in. The foreman transfers the necessary details from the report form to the record sheet for reference purposes and arranges for any necessary preventive work to be carried out.

There is a slightly different system also in use that details not only the specific inspections to be carried out but also specific routine maintenance tasks to be undertaken at the same time. Details of the work carried out are transferred to a record card which is kept in a cabinet for each item of equipment. See Fig. 2.

Planned maintenance was started to cover equipment that would cause serious loss of production or risk of human injury if a failure occurred. Such items initially included were cranes, centrifugal pipe-spinning machines and pressure vessels; and the system has now been extended to include all electrical equipment in certain foundries and items such as mold turnover machines, sand slingers, and also painting schedules and lubrication schedules.

The maintenance requirements vary considerably and it is necessary to describe the type of maintenance that is provided for different types of equipment to show clearly how the system operates.

Routine examinations of cranes are made by the maintenance personnel. The frequency and form of examination depends on the crane's duties, e.g., a telpher that carries ladles of molten metal is examined more frequently, especially its ropes, than a maintenance crane that is only used intermittently.

Shop-floor maintenance requirements vary a great deal and maintenance routines are largely governed by the plant working hours. For example, in one of the highly mechanized foundries at the author's company the sand slingers and mold turnover machines are in almost continuous use, and it is especially necessary for these machines to be maintained in good condition. The sand-slinger impeller tips are changed twice daily, during the mid-day break and after production has ceased in the evenings. Thorough weekly examinations are made of the mold turnover machines and sand slingers.

Some of the foundries at the

Fig. 2 . . Inspection guide that includes maintenance operations.

author's company are engaged in the centrifugal casting of iron pipes. The casting machines are not often available for internal inspections owing to the time required to open the water-cooled boxes. However, it is occasionally necessary to change the molds, and while this is being done the opportunity is taken to examine thoroughly the complete waterbox. The form used for this purpose is shown in Fig. 3. This type of form is designed primarily to remind the fitter of all the items that have to be checked so that the machine can be returned to service in good condition.

The care of air compressors and hydraulic pumps is of paramount importance to a mechanized foundry. These items are generally housed together and it is possible to employ a full-time operator to mind them, together with circulating water pumps and other similar items that are in the same area. The operator is responsible for the lubrication and cleanliness of the equipment and for detecting temperature rise, unusual noises, etc. The frequency of maintenance on the machines is governed by the plant-engineer's experience.

It is essential that a detailed lubrication program is set up and a team of really conscientious men trained to carry out the program. Not only do they attend to the lubrication but if encouraged they will also report in good time any defects noticed. Standardization on a few types of oils and greases should be aimed at, and care given to, ensuring that the oil and grease are kept clean. Where it is possible, automatic lubrication should be introduced. The savings in terms of increased bearing life, reduced maintenance costs and increased availability make this well worthwhile.

Control of dust and fumes brings its own maintenance problems. Foundry dust and fume control starts with the dust hood and ducts. Once such a system has been installed, every effort should be made to keep it in first-class condition. Dust accumulation must be removed regularly to provide the proper ventilation volume and promote the good housekeeping essential to the modern foundry. Dust accumulation in hoods and ducts can constitute a dangerous fire hazard.

Ventilating Ducts

When long horizontal ducts are used to convey dust-laden air to a collector, they should be so constructed that sections can be turned to a new position several times during the life of the duct. Otherwise, the abrasive wear on the bottom of the duct will cause premature duct failure. Fans should be examined frequently and the impellers cleaned. Cleaning and checking of fans can be done more easily if a section of the fan scroll sheet is removable. On all systems there should be sufficient access doors for cleaning and removal of dust.

It has been found that items that are out of sight tend to become neglected unless a system is evolved for their maintenance. For this reason, routine examinations are also made on all buildings and structures and a painting schedule has been drawn up to cover the whole of the plant. The schedule shows when each item was last painted and contains a detailed specification of the painting carried out. It also shows when an item should next be inspected.

The schedule has proved useful, as quite apart from ensuring that paint-work is not neglected, it provides essential data as to how different types have stood up to specific conditions. A standard form is used for the regular inspection of ventilators. It has been found that the ventilators in one foundry will require much more frequent attention than those in another, principally owing to the quantity of oil fumes condensing on the ventilators and clogging the moving parts.

It is the foreman's responsibility to organize the inspections and preventive maintenance, and the engineer's responsibility to check that the correct inspections are made and that the correct preventive maintenance is being carried out.

Periodic major overhauls—Preventive maintenance cannot always be arranged to enable plant economically to be kept in good order for an indefinite period.

There are types of plant that can be generally maintained in good condition by preventive maintenance, but in time a major overhaul will be necessary. Examples of other types of major overhauls that may eventually become necessary in spite of preventive maintenance are: a compressor may have to be re-bored and its bearings re-metalled; the arch of an annealing furnace may need rebuilding; a crane girder may have become bent and need replacing; or the heat-exchanger of a hot-blast recuperator may need re-tubing.

The execution of major overhauls of this nature must be carefully planned to cause least inconvenience to production. Where possible, these overhauls are carried out during plant shut-downs although there are instances, of course, where the work entailed cannot be completed during the time available.

The plans made include the preparation of spares, tackle and organizing the necessary labor. When the work involved does not require any specialist experience peculiar to the firm and when insufficient of the firm's men are available for the work, the possibility of the work being executed by outside contractors may be considered.

Whenever specialist knowledge is needed, it is always advisable to call in the makers either to supervise or carry out the complete overhaul.

Preparation of spares—The preparation of spares and the keeping of an adequate spares stock is a vital factor in the smooth running of any plant. The different types and numbers of spares to be carried must be decided on by the engineer, based on his knowledge and experience of the plant.

In the author's company is a plant register section which ensures that every item of plant has

Fig. 3 . . Form for inspection during non-scheduled overhaul.

WATERBOX INSPECTION FORM

MACHINE NUMBER:

Date of Inspection	Reason for Inspection	Rollers	Bearings	Keeps	Cradles	Pins	Pads	Adjusting Screws	Grease Nipples	Inspector's Signature

REMARKS:

IN THE CASE OF A 12'0" MACHINE USE NO. 1 TO 9.

SPIGOT END

KEY TO ROLLER NUMBERS

15.	12.	9.	6.	3.	BOTTOM ROLLERS
14.	11.	8.	5.	2.	TOP ROLLERS, SOCKET END
13.	10.	7.	4.	1.	BOTTOM ROLLERS

its own number. Because of the size of the organization, the amount of money involved in spares is considerable and it is necessary for the spare parts to be controlled by a spare-part store. All spares, whether made internally or purchased externally, pass through this department; and the stocks are kept up to normal in the same way as the ordinary store, using the maximum and minimum ordering-point system based on the current delivery position and consumption of each item.

It is appreciated that the smaller organizations could not carry such a cost, but there is no reason why the foreman cannot have a complete list of spares for each item of equipment which shows the position of his stock, giving such details as the rate of consumption, dates for re-ordering, items on order, etc.

Wherever possible, complete spares should be stocked. For instance, spare motors should have their pinions or half-couplings fitted ready and pump impellers should be fitted to their shafts. Every possible effort should be made to standardize, to keep the number of spares down to a minimum, particularly with items such as motors. The possibility of reclaiming spare parts must not be overlooked.

Breakdowns or emergencies—To deal quickly with breakdowns and emergencies it is necessary for the engineer to organize his department in anticipation of these. All vital parts of the plant during which a breakdown would affect the whole plant, should be surveyed. In anticipation of what could happen, handling facilities should be sited carefully, and in places not covered by a crane, tackle should be kept ready where possible, permanent tackle should be installed.

All breakdowns of any importance, whether they involve loss of production or not, should be thoroughly investigated to determine the cause of the breakdown and to ascertain means of preventing a recurrence. The method of executing a repair and the time should be investigated to ensure that, in the event of a similar breakdown, the previous experience gained is used to the best advantage to ensure the quickest possible repair.

A record should be kept of all breakdowns, showing the nature and cause of the breakdown and also the nature of the repair carried out. A daily stoppage sheet is sent in from each plant to the chief works maintenance engineer, even if it shows that no stoppages have occurred. Weekly summaries are made from the daily sheets and the stoppages analyzed to determine those that recur and those that should have been prevented. The stoppage summaries are an accurate guide to the efficiency and enthusiasm of a maintenance department. Stoppage sheets used are shown in Fig. 4.

Maintenance Costs

Maintenance costs will obviously vary as a function of the degree of mechanization and the tonnage produced in the foundries under consideration. In a highly mechanized foundry turning out large tonnages, the maintenance costs in terms of cost-per-ton may be only one-third of the maintenance cost of a jobbing foundry turning out comparatively small tonnages. It is necessary for a maintenance engineer to know precisely how the money is being spent if he is to keep his over-all costs to a minimum.

As already mentioned, each item in the plant at the author's company is distinctly marked with its respective plant number. Any work that is carried out and any spare parts used on an item of equipment are booked against the respective plant number on maintenance cost cards as shown in Fig. 5. The information on the card is fed to accounting machines and subsequently printed in monthly and quarterly summaries.

This system is necessary to the accurate costing of work carried out, particularly as work is sometimes undertaken by other departments for the foundries. Labor is also coded in the system, so that one can determine the type of labor involved in the maintenance costs.

From the maintenance cost summaries, one can determine when an item of a plant is costing too much in maintenance and consideration can then be given to replacing it by a more efficient machine.

Overtime is an item that can have a marked effect on maintenance costs, and there is a tendency to regard it as being essential to good maintenance. While it is realized that certain work can only be done at overtime rates, one must plan carefully to ensure that only work that is strictly necessary is thus carried out. Overtime graphs are kept, as they make obvious any tendency for overtime to increase.

Unless properly governed, stores can be issued unnecessarily and cause maintenance costs to be higher than they should. The number of people issuing stores requisitions should be limited and the monthly stores consumption sheet should be scrutinized to eliminate any extravagance.

Both production and maintenance departments should have access to monthly maintenance cost sheets as it is in the interests of both departments to reduce maintenance costs to a minimum, consistent with true maintenance of plant and equipment.

Much can be done by the maintenance engineer to reduce his running costs if he analyzes his costs to see where the same costs regularly recur and takes action to eliminate or reduce this expense. As an example of what can be done in this direction, automatic lubrication was introduced for the internal lubrication of the pipe-spinning machines already referred to. Quite apart from eliminating the need for a greaser, an increase in roller-bearing life of over 25 per cent was achieved.

Much money is saved by investigating ways and means of renovating or redesigning components in the light of modern techniques, to give longer life.

Greatly increased life has been obtained from components by the use of hard-wearing metal on surfaces subject to friction and abrasion. For instance, the rams on hydraulic-ram pumps are hard chromium plated.

Relations Between Production and Maintenance

This is an aspect of maintenance which cannot be stressed too greatly; in fact, it could be called the most important aspect. To be successful, a maintenance department must work as a team, but it is of far greater importance that the relationship between that department and the production department is satisfactory.

Upon the close co-operation or team spirit between the two departments depends the whole success of good maintenance, which should and can mean continuity of output with minimum cost. This can only be achieved by the close working together of the two departments, each department working for the good of the concern as a whole. Planned maintenance, intelligent anticipation and keenness are useless unless the equipment is handed over to the maintenance department at the right time.

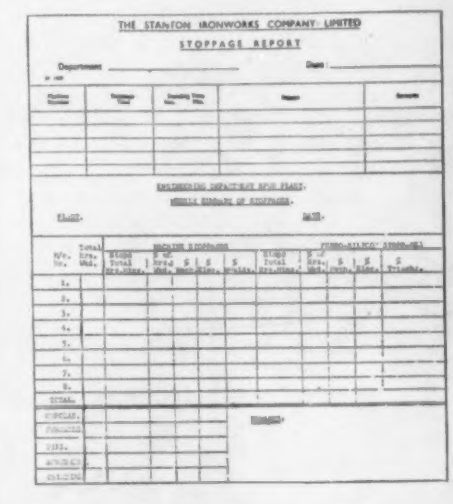


Fig. 4 . . Breakdowns noted on reports.

There may be some change in the production program which might mean that certain items of the plant would be standing for a period.

Informing the maintenance people of this beforehand will enable them to carry out any repairs which were in mind and so save a stoppage at a later date and perhaps overtime payments.

Much can be achieved in this direction by the plant manager inviting maintenance foremen to his production meetings, as is done in certain sections of the author's company. Output figures are dis-

Fig. 5 . . Maintenance cost cards.

cussed, and the output of any stoppages, in terms of tons lost, is pointed out. This tends to bring the maintenance section more into the plant and stoppages are related more to output lost rather than just time standing. The proceedings are carried out in a friendly manner without any idea of apportioning blame. Criticisms are made, and suggestions for improvement are given without any resentment from either side. A better understanding of mutual difficulties is reached, and the old idea of *it's not my job* is disappearing, and in its place is substituted *it is our job*.

Good Housekeeping

Another aspect of maintenance which should be mentioned, and which is in keeping with a paper of this nature, is good housekeeping. Much has been said on this subject, and while there is no doubt that a lot has been done, there is still room for improvement in many foundries and workshops. Anyone who has visited a plant where good housekeeping is obvious by its absence can realize the effect on the morale of the foundry personnel, and the attitude they adopt towards equipment.

One cannot expect individuals to work in an orderly manner when all around them is disorder. The fact that good housekeeping goes with good maintenance and is of the utmost importance cannot be sufficiently stressed.

Good housekeeping is not only keeping the place tidy by seeing that materials, etc., are not left lying around in a disorderly manner, but also of providing and maintaining conditions in which the worker can work in the most orderly and efficient manner. Also it consists of providing adequate gangways properly maintained, and clear convenient racks, bins, etc., for the storage of miscellaneous clamps, etc., and the stacking of molding boxes and tackle in a safe and orderly manner, either in the shop or outside, according to whether or not they are in use.

Attention should be given to the cleaning of all glazing, especially roof glazing, so as to give the best-possible natural lighting. It is appreciated there is a difficulty here because, whereas most types of buildings have a walkway on the outside of the roof, very few have easy access to the inside of the roof glazing. Not all the dirt is on the outside of the glass, especially in foundries. Roof designers might well bear this point in mind. In shops with roofs of corrugated sheeting where there is a lack of glazing, considerable improvement in natural lighting can be obtained by use of transparent plastic.

Safety is another item in good housekeeping. With proper gangways and materials stacked in an orderly manner, the hazards of the work are considerably reduced. When it is realized that a large percentage of accidents on any works is due to people falling, not only from a height but at ground level, it would seem that everything be done to ensure the safety of workers.

There is one final point under this heading. In any undertaking there are three factors; materials, equipment, and the human element. No matter how highly organized or mechanized a foundry may be, its success or otherwise depends on the health and well-being of the people employed there. A happy and healthy staff, able and willing to give full-time service with a minimum of absenteeism from whatever cause, is essential. Money spent to this end is a sound investment.

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1958 TRANSACTIONS PREVIEW

PREVENTION BY THE OUNCE

By

F. J. Dost and G. P. Ribar*

INTRODUCTION

If it is assumed that, in the modern foundry, it is economically advantageous to have substantially all the means of production available to the producing forces during their scheduled working times, it follows, that adequate effort to effect such availability is amply justified.

The manifestation of this assurance to produce, is apparent in the activities of the plant maintenance department. How well it selects, installs, inspects, maintains, and counsels in the operation of the foundry plant components will determine, to a great extent, the degree of availability.

This report is a summary of maintenance practice at the authors' company. At this company gray iron, alloy gray iron, and ductile iron castings are made in a semi-mechanized shop of about 750 tons per month capacity. Molds are approximately half dry sand and half green sand, casting weights are from about 1 lb to 10,000 lb.

We have been asked to comment about our specific programs of preventive maintenance concerning: 1) electrical equipment, 2) material handling and cranes, 3) melting equipment, 4) fuel burning appliances, and 5) the compressed air system.

Before entering the individual categories listed, the authors would like to stress the accent given to lubrication, cleaning, and inspection. Generally, where there is no hazard of pushing out seals, or contaminating electrical insulation, or the process, parts are overlubricated weekly in the belief that keeping lube in keeps dirt out. Cleaning of electric motors and controllers, air moving impellers, ducts and filters, cranes, motive units, and machines in general, with blow pipes uncovers most of the locations where failures could occur. These two preventives lead to practically 50 per cent automatic inspection, considering that inspection is the cornerstone of successful maintenance. For if inspection is not done, it can not be known; if it is not known, there is no prevention; and if there is no prevention, failure follows.

The topic of electrical equipment is divided into two broad classifications: A) power supply, and B) utilization apparatus.

Electrical energy is purchased at the 60 cycle, 240 volts, 3 wire, 3 phase, ungrounded secondary of a 600 KVA utility furnished delta-delta bank of 6 single-phase transformers. This enters the plant through three 1,200 amp., 3 pole amp-trap fused main switches; thence to "super-lag" fused panels at centers of load. It then goes by sub feeder or branch circuit to the different work centers. This will be recognized as a secondary radial system requiring fusing and conductoring in multiple.

POWER SUPPLY

The inspection of this electrical backbone is semi-annual. Temperature testing is done by touching all lugs (Fig. 1), conductors, switch contacts, fuses, fuse clips and clamps, and fuse panels. The currents in the parallel paths are checked with a tong-test ammeter (Fig. 2), to prove even division of load. Renewable fuses are completely disassembled at times of no load and the links carefully scrutinized for evidence of notching, fatigue and oxidation. Fuse link contacts, fuse blades, fuse clips and fuse holder contacts are fine sandpaper cleaned before assembly, and securely clamped in the clips everywhere space permits fuse clamps to be installed.

The check is also made at peak-load currents on the utility's paralleled transformers as well as each Monday morning during the thunderstorm season, proving continuity of the transformer primary fuses. The utility cleans the cutout contacts and replaces the primary fuses at plant vacation time.

This close attention to fundamentals has resulted in an enviable availability of the secondary electrical system. All components operate with moderate temperature rises, and at or below National Electrical Code ratings. In its over 15 years of continuous operation, the distribution system has not been down once from causes within the plant. With the electric power supply dependable, a host of collateral production necessities are kept available.

On a different tariff schedule, energy for a 250 KVA, size U, direct-arc furnace, is purchased separately at utility primary voltage. All of the activities mentioned in connection with the low-voltage system are employed here, except that temperatures by touch are not taken while this service is energized.

An incidental benefit of the peak-load ampere measurements is that a good load study can be made by

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*Sterling Foundry Co., Wellington, Ohio.

Fig. 1 – Temperature testing by touch on lugs, switch contacts, fuses, fuse clips and clamps, and fuse panels which are inspected semi-annually.

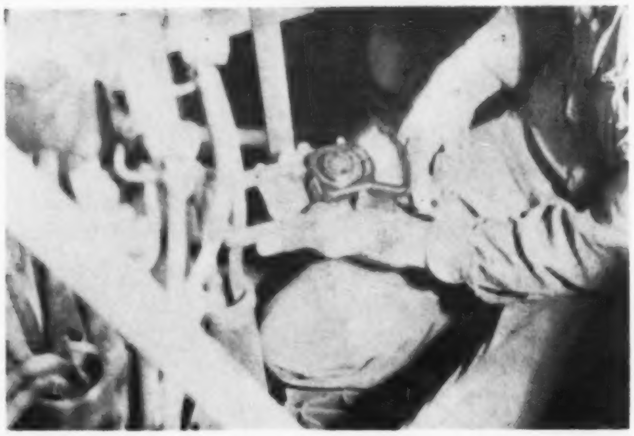

Fig. 2 – The currents in the parallel paths are checked with a "tong-test" ammeter to prove even division of load.

merely recording the tong-test readings. Such a survey, in conjunction with proposed building and motorized process additions, indicates the magnitude and direction in which to expand the power supply. A second radial secondary system beyond the economic reach of the existing service is now being built.

It is to be understood that a power supply that is protected with devices of insufficient interrupting capacity, is grossly overfused, inadequately conductored, or carelessly installed, cannot be prevented from failing, and will probably cause a disastrous fire when it does fail.

UTILIZATION APPARATUS

The prevention program for this category of plant centers about a file containing an individual card for every electrical item on the premises. Electrical equipment items as: a) motors and controllers, b) magnetic brakes, c) rectifiers and generators, d) lifting magnets and magnetic pulleys, e) heating devices, f) lighting, and g) signals are all listed. In complementary files are kept the parts lists; installation, operating, and adjusting instructions; wiring diagrams and literature helpful to the work of the department.

Electric Motors

Motors are blow pipe (25 psi max.) cleaned on schedules varying from two weeks to two months, depending on size, exposure to unfavorable ambient and motor type. Wound rotor types are especially watched for buildup of carbon dust from the brushes in addition to the prevailing foundry dusts. Those open motors on which the insulation resistance cannot be satisfactorily maintained by blowing, are taken out of service at intervals of about three to five years, disassembled, solvent cleaned, dried, and revarnished before being returned to use.

Wound rotor types are also inspected for freedom of brush movement, evidence of arcing, length of brush, cleanliness of brush rigging and inter-collector ring insulation, as well as continuity of the motor secondary wiring.

Ordinarily, electric motors are not regarded as expendable, and overload protection is applied accordingly. Where thermal overload relays are used on 40 degree rise continuous ratings, protection is in the range of 110 per cent-125 per cent; on 55 degree rise continuous ratings, 105 per cent-115 per cent. Where renewable super-lag fuses are used, principally, for 55 degree rise, 30 min, wound rotor motors on cranes, protection is at about 150 per cent, in any case, always using the smallest size which will keep the motor running without premature fuse blowing. Where dual element fuses are used, mainly for 55 degree rise 180 cycle portable grinding tools, protection is at 110 per cent.

A conspicuous exception to over lubrication, as noted before, is electric motors. Here, lubricant is applied sparingly. Ball bearing motors are lubricated by grease gun, with the relief or sump plug of the bearing capsule removed. Only enough lube is added to replace the old. Where it is evident that the old grease is excessively hard, the motor is disassembled and the bearings thoroughly flushed with warm oil. Capsules are then repacked one-third to one-half full upon assembly of the motor.

Sleeve bearing motors are oiled by addition about once a month until the oil in the sump shows contamination. Oil is then drained and replaced with new.

Flange mounted motors are inspected closely for migration of lube from the associated gear case or crank case. Regardless of how well the shaft seals are maintained, a tendency for lubricant from the gear box to move along the shaft and be centrifuged into the windings has been noticed, which, along with the ever prevalent foundry dust, causes rapid deterioration of the insulation. It is important that the gear box not be overfilled, and that the vent to the case be kept open.

The authors' company also touch-temperature tests motor bearings and stators, inspects frame hold-down bolts, sheave, belt alignment and tension, coupling or spur gear of each drive twice a year as it fits into the cleaning cycle.

Motor Controllers

These elements, perhaps more properly an item of power supply, are grouped with motors because of concurrence of inspection; and since a division can be made between power supply and utilization, it is convenient to do at the motor disconnect switch.

The devices in this class which are inspected most frequently are reversing drum controllers for wound rotor motors as used on cranes. The authors' company lubricates the contact finger tips and segments with petroleum jelly at intervals of from one week to three weeks, depending on frequency and severity of operation. Contact pressures are adjusted, internal connections of segment to segment, tips to fingers, fingers to shunts, shunts to external wiring, are all tested and examined for tightness and evidence of excessive arcing. Shaft bearings are lubricated and checked for wear. Once a year the drum is removed from the controller, washed in solvent, dried, and varnished on the insulation before returning to service.

By far the greatest number of motor controllers is magnetic contactors, as used in across-the-line starters. In the usual application, requiring only a few operations daily, the principal preventive used is air blow-gun cleaning at about three month intervals, particular attention being given to removing magnetic particles in the magnet structure and pivots, which foreign material if not removed, causes sluggish action. Starters are worked over annually, contacts being dressed, bearing points, blowouts, connections, shunts, interlocks, holding coils and magnet-mating are inspected in detail.

There are a few installations of pilot master-magnetic contactor switching on the cranes. The pilot masters are treated as miniature drum control, and necessarily much more attention is given to the contacts, magnet frames, pivots and hold downs of the contactors, because of the frequency of stress in this application.

The tanks of oil switch starters are lowered once a year for complete inspection of contacts, linkage, connections, oil and contact alignment. The manual or solenoid operator is examined for wear and freedom of movement.

Magnetic Brakes

The magnetic brakes are of the spring set, shunt connected, alternating current type. Actuators are of solenoid, or of armature and "C" core design, about evenly divided between shoe and wheel, and, disc and plate brakes. These brakes are used to control coasting of de-energized hoist motors. Since many of the hoists are used to draw large patterns and core boxes, and to set heavy cores, as many as 100 pulses in 2 or 3 min are given to motor and brake to raise or lower these loads. This severe punishment of the brakes means frequent preventive action if high availability is required.

At periods of from twice weekly to every two weeks electric brakes are inspected. If the plungers or armatures of these magnetic circuits do not quickly move to sealed position when energized, the electrical reactance of the coil remains quite low, permitting as much as 20 times normal sealed-in current to flow, so that the coil is destroyed in a short time.

It has been found that almost any single fault in the brake assembly or adjustment, contributes to sluggish action (Fig. 3). Therefore complete brake examinations are made. The check points are: bolts securing brake frame to machine, fastening of coil to brake base, connection of supply wires to coil, travel and alignment of plunger or armature, impacting surfaces of magnet, non-magnetic guides and anti-freeze shims, jam nuts which fix length of travel, trunnions, pivots, bearings, arms, levers, links, pins, cotters, spring tension, lining and wheel surfaces. The brake is exercised manually to test accumulated play. The motor controller is operated a few times while watching and listening to the brake.

Fig. 3 – Complete brake examinations are made at various check points. Inspector is shown testing magnetic brake.

This procedure though sounding lengthy, can be performed by an experienced mechanic in five min and pays off handsomely in hoist availability.

The disc and plate brakes used are mostly of the dry lining type mounted against a gear case. Gear lubricant eventually works through the seal causing some slippage. When the coasting or drift of the hook increases beyond normal, the lining surfaces are cleaned and the seal is replaced, usually about annually.

Generators and Rectifiers

There is no central source of direct current power at the authors' company. Rather, alternating current is converted on-the-spot, for magnetic pulleys, lifting magnets and field supplies of synchronous motors. Inspection, cleaning and lubrication as outlined for wound rotor motors, is followed on rotary generators. Additional consideration is taken of the peculiarities of commutation, by sanding the commutator, and fitting brush ends to radius. The authors' company also inspects field rheostat contacting annually. When the commutation can no longer be satisfactorily maintained by sanding or stoning, (about five years), the armature is taken out of service to turn and undercut the commutator, and, clean and revarnish the winding.

On electronic tube-type rectifiers, it has been found that the tube socket insulation and contacts are a point of weakness that can easily be controlled by cleaning. Tubes are replaced at about rated life.

Lifting Magnets and Magnetic Pulleys

On the lifting magnet, used with an overhead electric traveling yard crane to unload railroad cars and make up cupola charges, the principal item of maintenance is power supply. The disconnect plug contacts

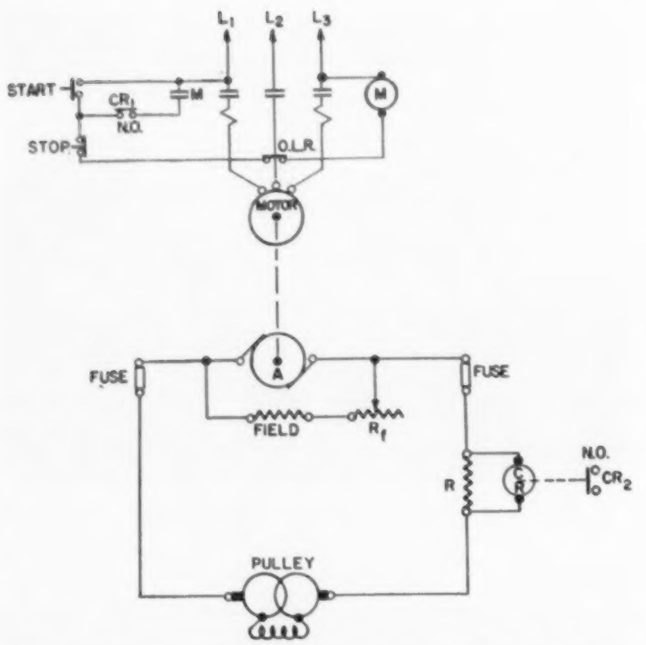

Fig. 4 – Control circuit proving magnetic pulley excitation. Register R is inserted in series with supply conductor, generator to pulley. R is adjusted to give a drop of 6-8 volts. CR is a two-pole, N. O., 6-volt D. C. relay. Contact CR_2 is inserted in series with stop button of starter for pulley mechanical drive. The motor-generator starter will not seal, nor will pulley drive start unless CR pulls in.

and housings are cleaned monthly. The retrieving cable reel collector rings and brushes are inspected at the same time as the crane trolley.

The magnetic pulleys are wound, with the coils concentric to the shaft (Fig. 4). Some stray flux flows through the ball bearings on the shaft and through the steel enclosures. This attracts ferrous dust to the bearings and even with the best cleaning that can be given these units, bearing life is shortened to about two years. The current collector rigging is treated much in the same manner as that on a wound rotor motor.

Heating

The principal electric heating load at the authors' company is a three-phase arc furnace. Many of its components fall under classes previously discussed. Extra preventives include, semi-annual insulation resistance tests and chemical cleaning of the cooling water system, monthly cleaning of electrode supporting masts, and demand check to prove power factor improvement capacitors are energized.

Lighting

Reflector cleaning is done about quarterly by personnel of the departments in which the lighting is located. Lamps (incandescent, mercury vapor and fluorescent) are replaced as they burn out. A few spare extension cords are kept in those departments which need them in their work, obviating the delay of waiting for repair of cords damaged in service.

Signals

A personnel paging system is pulsed by a small motor-driven master-sender and propagated by cascaded control relays, which derive their power supplies near the bell and horn locations. Elements of this system are regarded as motors and controllers, maintaining as outlined above.

A railroad siding enters the yard building. Two crossings of this siding by interdepartmental gangways are warned of car movement by bells energized from a switch located at the out-bound end of the building. This switch is operated by the train crews as they enter and leave. This signal is tested weekly.

Where lamps are used as signals, the authors' company tries to arrange the circuit so that the lamp is normally lighted. Malfunction of the supervised process is then indicated by dark lamp, which also continuously proves the lamp itself so long as the process system is energized.

MATERIAL HANDLING

Here it should be remarked, that all job evaluations and standards throughout the plant include a liberal time allowance for every man to clean up his work area and machine. This is a very worthwhile assist to preventive maintenance. All employes are encouraged to report through their supervisors, any unusual noises or conditions detrimental to the equipment. The maintenance department attends to that cleaning where ignorance of hazards or process could cause injury or damage. Much of the cleaning of material handling units is done by production personnel. Lubrication is by maintenance.

Self-propelled Vehicles

Such machines as: fork lift truck, front end bucket loader, dump truck, and gasoline powered sand truck are in this category of self-propelled vehicles.

A very reliable aid to the preventive maintenance of this class of equipment is the engine-hour counter. Such a clock is connected under the ignition switch through an engine oil pressure switch. So arranged, it logs engine-hours. This is a very useful guide in programming such work, since there is a close relationship between engine-hours and every other motion on these machines.

The preventives here consist of engine oil and oil filter change; chassis lube, check of hydraulic systems' fluids and filters; air filter, distributor point and spark plug changes; battery water level and tire check. Other electrical components are treated as previously outlined.

Cooling water level, engine oil level, fuel supply, air blow-pipe cleaning, are daily responsibilities of the operator.

At about 3,500 hr, the engine can no longer be facilely maintained by these measures, and arrangements for overhaul and loan truck are made with the manufacturer's agency. It is commonly believed, that each engine-hour on an industrial truck is equal to 40 miles of passenger automobile operation.

Towed or Pushed Vehicles

Core oven cars are lubricated with high-temperature grease before each bake by production department personnel; wheels, axles and bushings are replaced as wear becomes excessive.

Narrow gage rail cars are lubricated weekly; bearings, wheel treads and flanges are inspected at the same time.

Rubber-tire wagons, carts, hand trucks, and ladle buggies are lubricated weekly; tires and bearings inspected for wear.

Belt and Gravity Roll Conveyors

On belt conveyors, rubber belts are inspected for side seals and tracking, and lubricated weekly. Hot sand belts are checked for tracking daily.

Gravity roll conveyors are cleaned by the departments in which they are located. Individual rolls in sections of pour-off conveyors which become damaged from spillage of molten metal, are repaired by the maintenance department.

Bucket Elevator Boot and Clamshell Buckets

Bucket elevator boot pulleys are lubricated daily. Buckets on prepared green sand elevator, chutes and hoppers are cleaned daily by operating department personnel.

Clamshell buckets are lubricated and inspected weekly. Lips, operating mechanisms and bushings are replaced as wear becomes excessive.

Molding Machines

Lubrication and check of jolt action daily. The oil level of the hydraulic system, levelling of rollover plate (Fig. 5), speed control of rollover and draw cylinders, and bunter valve inspected weekly. Exhaust examined weekly for presence of excessive oil. Machine exterior clean-up daily and pit clean-up as required, by production personnel.

Sand slinger electrical and machine components are maintained as explained under those classifications; liner and cup changes as required, and daily clean-up of elevator buckets and boot are done by the operator.

CRANES AND HOISTS

There are 26 overhead electric travelling cranes which service over 75 per cent of the plant area. Fifteen of them are cage or cab operated, the remainder are operated by push-button or rope from the floor. Spans range from 15 feet to 70 feet, lifts from 10 feet to 30 feet, runway lengths from 40 feet to 700 feet. Capacities are from 1 ton to 15 tons; closely matched to the loads which they are required to lift.

Over a period of years, the mass of the larger castings has increased. This has increased the size of flasks and weights of sand the cranes must handle. During the same time, however, existing cranes were up-rated where possible, or relocated from heavier to lighter work load areas, and some new cranes purchased.

This is cited as an instance clearly demonstrating an essential function of top management in preventive maintenance. For if the physical facilities are "thinly-sized" originally, or not "beefed-up" as the process expands, upkeep will consist of repairs between breakdowns, not planned preventive maintenance as the term is understood.

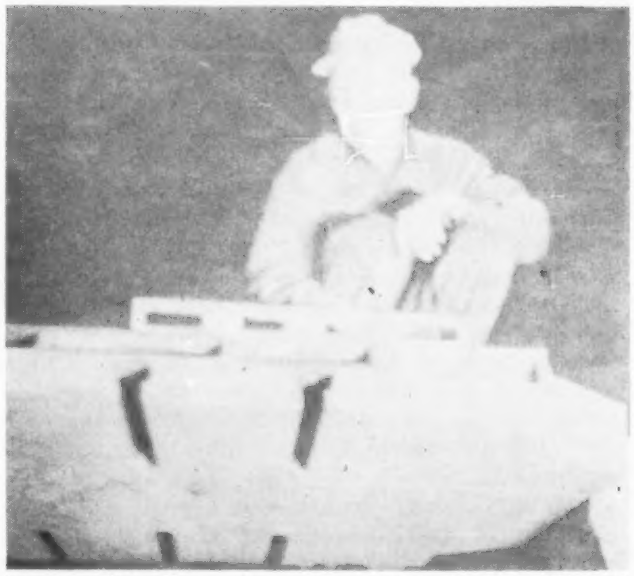

Fig. 5 – The rollover plate is inspected for level weekly with a spirit level.

In addition to the electrical work on cranes already delineated (topic 1), cranes are inspected on an average 60-day cycle for: collector wheel groove, bore, and axle wear; wheel, axle, wheel staff, and lead-off wire securance, clearance, and insulation; slider shoe groove wear, shoe and lead-off wire securance and insulation, and evidence of excessive arcing. Transverse collector wires are inspected for tension, whip, securance and connection of lead-off wire. The limit switch is inspected for contact wear, contact lubrication if the switch is of segment and finger type, freedom of movement and securance of lead-off wire.

Mechanically; hoisting cable, sheaves, load block and hook are inspected weekly for damage and wear (Fig. 6). Lubrication of bridge drive wheels and idle wheels, bridge squaring shaft, trolley drive shaft and wheels, cable drum shaft, cable sheaves, check of bridge brake hydraulic fluid level are done weekly.

There are also 20, one-ton "package" hoists, captive to a machine or work station. Although all of

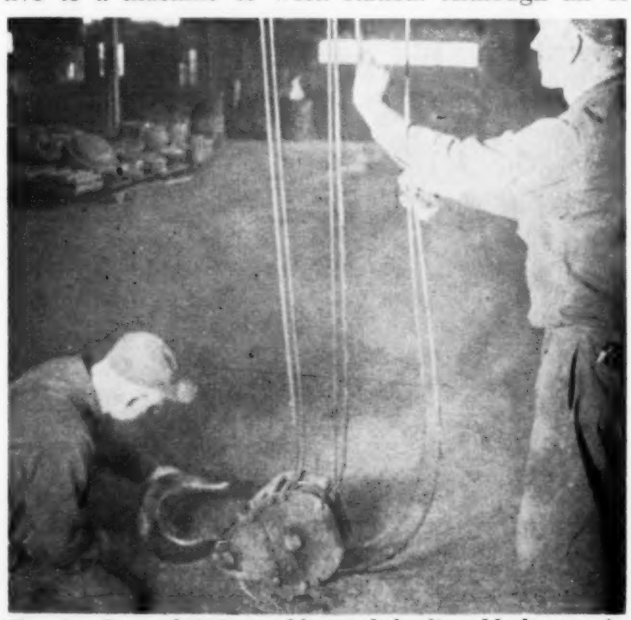

Fig. 6 – Crane hoisting cables and loading blocks are inspected weekly for damage or wear.

the precautions mentioned are followed, occasionally a load becomes fouled with the power supply cord tearing it out of the hoist. It is then faster to substitute another hoist than to repair it on location.

MELTING EQUIPMENT

The principal melting units are 2 No. 8 cupolas lined down to 54 in., operated in daily alternation, at a melting rate of about 10 tons per hr. Refractory maintenance is daily by the melting department using the "cupoline-bondactor" process. Gun, guntips, hose, hose connections, agitator parts, valve or door seals are kept in stock and replaced as they wear. The only items of lubrication here are the agitator air motor, which is oiled daily, and the agitator gear box, which is inspected monthly, lubricant being added as required.

Combustion air is supplied from a positive displacement blower instrumented with air-weight control. Blower lubrication is inspected daily. Blower internal clearances are gaged annually. Instrument air piping is cleaned annually by compressed air, blowing away from the instrument. The instrument is worked over semi-annually by contract arrangement with the manufacturer's service department. The diaphragm operated butterfly spill valve of the air weight control system is inspected monthly for integrity of linkage.

Hopper of metallic charge scale is lubricated weekly. This scale and coke scale are tested and adjusted semi-annually under contract with the scale manufacturer's service organization. Charging buckets are used in pairs for which there are spares. As they depreciate they are repaired by electric welding. Cupola shell, wind-box, and air passage tears are repaired by electric welding on the off day of the cupola.

Reservoir and pour-off ladle trunnions are greased daily. Gear box lubricant level is inspected weekly, ladle bails daily. Cupola bottom doors and door posts are kept in stock.

FUEL BURNING APPLIANCES

The natural gas service used in the plant originates at the utility company's meter-regulator station, where pressure is reduced to 1 psi, enters the plant, and is radially distributed through a piping system with sizes tapering toward the extremities. Most appliances are re-regulated to a pressure range of 2-6 in. W. C.

The principal preventive with gas consuming equipment is cleaning combustion air passages. Twice a year blower impellers and scrolls, piping, air flow switches, pressure switches, diaphragm operated butterfly valves, slide gates, mixers, manifolds and burner tips are blow gun cleaned. In certain instances where this is insufficient, components are disassembled and solvent cleaned.

It has been the company's experience that dirty passages reduce input, cause erratic temperature control, and induce spurious response in the electronic flame detecting devices, that slugs of dirt in the flame are interpreted by the electrode as a ground and unnecessarily shut down the burner.

Particular attention is paid to lighting and pilot burner mountings and flame adjustments, to insure prompt ignition of the main flame. Electron tubes of the flame relays are replaced at rated life. Operating personnel are encouraged to perform normal shut-offs by closing the manual valves, thus proving the safety system.

Gas space heaters using finned and tubular heat exchanges are cleaned yearly. Pilots are extinguished and main flames subjected to ninety seconds maximum count down.

COMPRESSED AIR

Compressed air supply is from two 125 h.p. synchronous and one 75 h.p. induction, integral motor driven two-stage compressors, each with individual aftercooler and receiver. Units are of the total unload electro-pneumatic control type. Pressure switch ranges are set at 102 psi-95 psi, 100 psi-93 psi, and 98 psi-90 psi, commencing from the newest machine. They are switched on and off the line by schedule.

The outstanding preventive here is lubrication. Crankcase oil is changed on a 30 day routine. Force feed lubricators to top of cylinder, crankcase oil lever, trapped condensate drains of intercoolers, interstage pressure and receiver condensate bleeding are checked daily.

Lead machine valves are worked over at 8-month intervals, the others annually. Intake air filters are cleaned monthly. Distribution piping is uncapped and blown out at the extremities yearly. Semi-annual tests are made of system capacity and losses.

In conclusion, all of the foregoing was much more aptly stated by Ben Franklin when he said "A stitch in time, saves nine". For if all troubles are little ones, the big ones can be prevented; and if these are prevented, there is no failure.

ESTABLISHING AN EFFECTIVE PREVENTIVE MAINTENANCE PROGRAM

By

W. Huelsen*

Good maintenance is a philosophy, not an afterthought. Unfortunately, maintenance people are too frequently considered as not contributing directly to the manufacture of the finished products of a company, hence are considered overhead. The only reason for existing then is to provide the manufacturing department with the service necessary to get the maximum utilization of all equipment available.

A maintenance department can have either of two philosophies: 1) to repair equipment when it breaks down, or 2) to maintain the equipment to prevent and minimize breakdowns. The old philosophy, the repairing of equipment when it breaks down, is really maintenance by crisis or simply waiting for equipment to break down, and then doing only enough repair work to get it in some semblance of operating order until more time is available to do a better job. The new philosophy, the maintaining of equipment to prevent or minimize breakdowns, is much more difficult because it requires careful thought and planning for effective operation.

A GOOD PREVENTIVE MAINTENANCE PROGRAM IS A MATTER OF LOGIC

The establishment of a good preventive maintenance program requires the planned application of the logical steps that should be taken when the old philosophy of maintenance by crisis is in effect.

These logical steps are: 1) to fix the equipment affecting the greatest number of people when two or more breakdowns occur at the same time, 2) when a piece of equipment gives trouble periodically, check it over at regular intervals to see what condition it is in, 3) if a part wears out rapidly or breaks easily, design and make a better new part, and 4) make notes and sketches on how a job is done, when to do it or how much it costs, and file them for future reference. By clearly stating the logical steps of the old philosophy of the maintenance by crisis sequence into four basic goals to be accomplished, a preventive maintenance program begins to emerge.

First, list the pieces of equipment in each department or operating area in the order of their importance or, more simply, list the equipment that will idle the most people when it breaks down, in a descending order. Second, set up a regular routine for checkups, repairs and general overhaul of equipment. Third, follow through on step two with design changes, such as heavier duty parts improved material specifications, standardization of parts or pieces of equipment, maintenance instruction sheets, and assembly drawings. Fourth, keep only those records that are necessary for efficient operation.

UTILITIES ARE MOST IMPORTANT, CHECK THOROUGHLY

When enumerating the equipment most important in each operating area or department, utilities must head the list because without them very little else can operate. They include electric power, gas, water, compressed air, heat, sewers, and fire protection systems.

The first thing to know for good maintenance of an electric-power system is the total connected load, demand factor, and power factor. These same things should be known or measured for each main circuit in the plant. This will insure that transformers, transmission lines, and electrical equipment are not damaged by an inadequate power supply and distribution system.

Gas, whether natural, manufactured or bottled, is being used more extensively throughout the foundry industry each year. It goes without saying that the gas supply lines must be checked periodically for leaks. Various state and local laws and fire insurance underwriters require certain protective devices on both the distribution system and on the gas-burning equipment. These protective devices should be thoroughly checked and tested as recommended by your insurance underwriters. All gas outlets should be color coded or tagged so they may be easily distinguished from compressed air or water lines.

Compressed air is an expensive and an important source of energy for almost all foundry operations. It takes approximately 5-1/3 compressor horsepower to generate the 100 psi air lost through a 1/8-in. diameter hole. A good way to check the efficiency of the compressed-air transmission system is to record the

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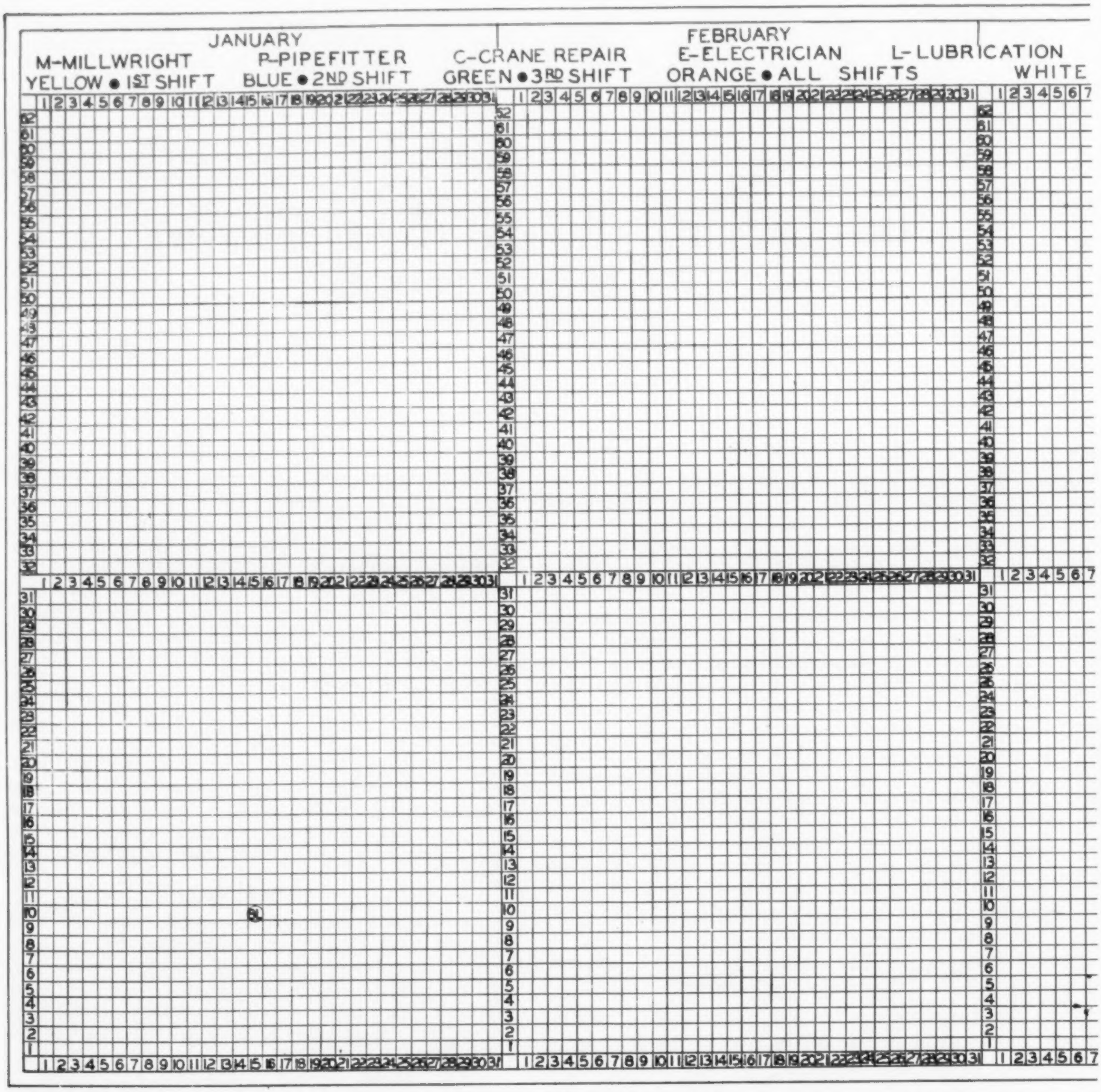


Fig. 1 – Scheduling board for preventive maintenance program.

power consumed by the compressor in satisfying the air leaks during a non-operating shift.

The compressed air system efficiency can be simply calculated by the following formula:

$$E = \frac{P_T - P_L}{P_T} \times 100$$

Where: E = System efficiency.
P_T = Total power supplied to the compressor during production.
P_L = Power supplied to the compressor for leaks.

The true cost of air leaks in dollars can then be calculated by:

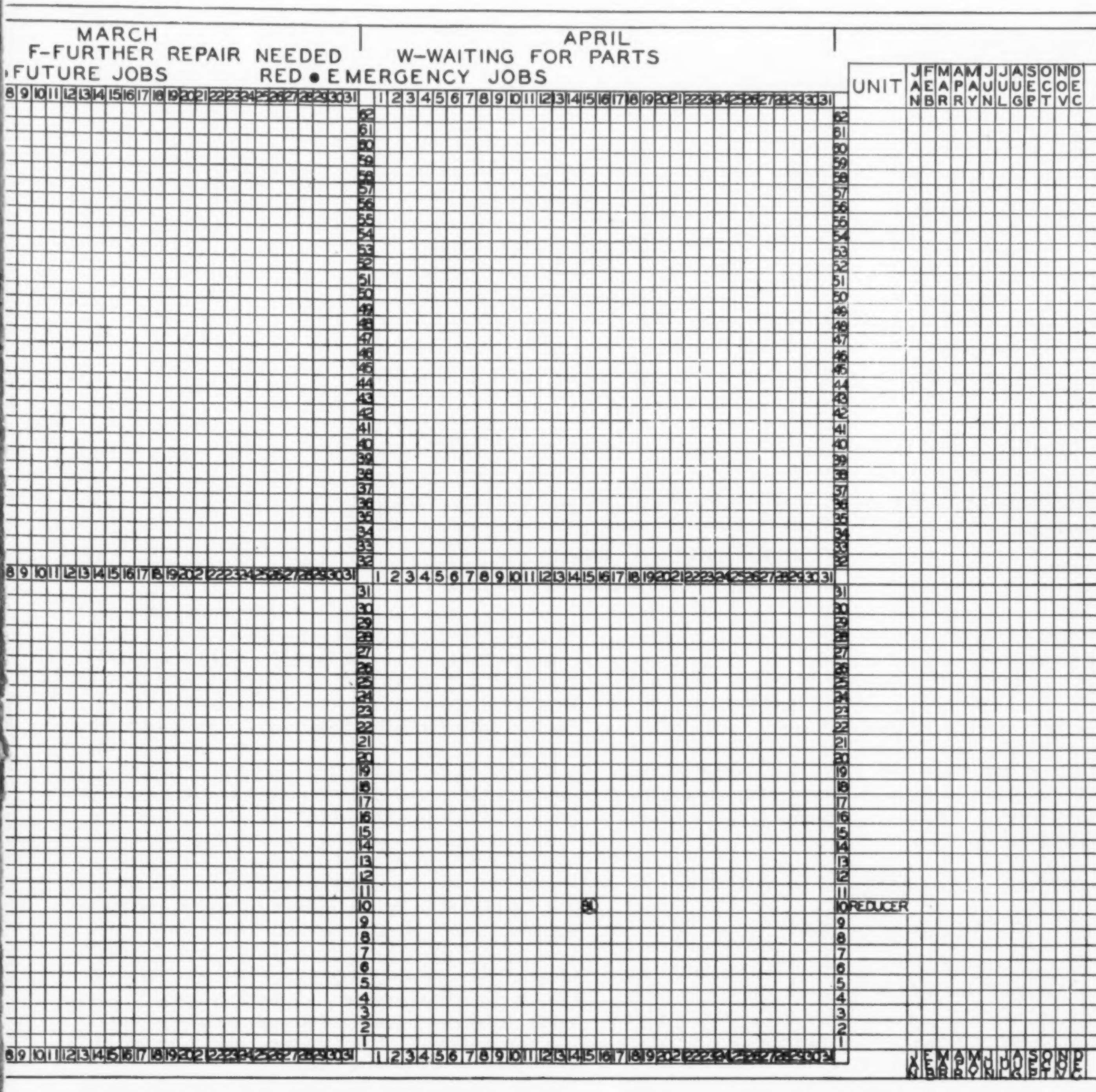
$$\frac{(100 - E)\ (C_T + C_M)}{100}$$

Where: C_T = Total compressor power cost per year.
C_M = Total compressor maintenance cost per year.

In any case, the power consumed by the air compressor to supply leaks should be recognized as part of the plant maintenance cost.

Air compressors should be located in a separate, clean, well-lighted, and ventilated enclosure. There should always be enough capacity to supply the required volume at the proper pressure the year around. It is also desirable to have a standby unit available when one compressor breaks down. When a standby compressor is available, it should be operated at least once each week for a sufficient time to keep it in good working order.

Water is our most plentiful and least costly natural resource, but it should not be wasted. Water is used



in innumerable places for industrial processes, human comfort, and consumption. This supply can be most easily maintained by installing loops throughout the foundry building so that water is continuously fed into both ends of the system.

Water supplies for fire protection should be installed, tested and maintained according to the local building code and recommendations of your own fire insurance underwriting company. This is a most important maintenance function because even though no one may be hurt, a fire can bankrupt a company and cause great losses to its employees and the community.

Another important class of plant equipment is the machines that service a large number of people. This group includes such things as melting furnaces, cupolas, cranes, sand mixers, sand distributing systems, ovens, conveyors, blasting machines, and trucks. The relative importance of equipment in this group will vary for each foundry, depending upon its type, size, class of work, and methods of production.

PLAN FOR PREVENTIVE MAINTENANCE

In order to properly plan a preventive maintenance program, take each individual machine and assemble all of the maintenance information available on that machine. This information should include parts lists, lubrication, operating, and maintenance instructions. All of this information is usually supplied when the equipment is purchased, but if it was not supplied or has been misplaced, extra copies should be available from the various equipment manufacturers, on request. Many of these companies also have servicemen who consult on individual problems and will help

MANUFACTURER FALK MODEL 22DU SERIAL NO. 155-443 JOB NO. 8L

MACHINE NO MP4497 LOCATION BB-40-41-0 SHIFT 3

JOB FREQUENCY 3 MONTHS STANDARD TIME .50 HOURS

JOB DESCRIPTION

DRAIN REDUCER, FLUSH WITH C.T.CO. #FX-99015, AND REFILL

WITH SAE #40 OIL C.T.CO. #FX99003.

GREASE COUPLING WITH C.T.CO. #FX-99024.

CHECK AND NOTE ALL OIL LEAKS.

REFERENCE MATERIAL FALK BULLETIN #3800 & 4152.

SPARE PARTS LIST, PAGE #62.

MAINTENANCE JOB DESCRIPTION SHEET

Fig. 2

set up a good preventive maintenance program for equipment of their own manufacture installed in the purchaser's plant.

Other information that should be collected on each piece of equipment will include both full- and no-load motor amperages, speeds, pressures of gas, water, air and hydraulic fluids, and damper, valve or timer settings. If this information is obtained during normal operation, it can be compared to the same data taken when the equipment is operating improperly and can help pinpoint the actual trouble.

DESCRIBE INDIVIDUAL JOB AND ESTABLISH INSPECTION FREQUENCY

After studying each piece of equipment, list the items to be checked and the time interval between checks. As each item is listed, notes on how the check or adjustment is to be made, complete with all of the information available on the machine performance and wear limitations, should be included.

MANUFACTURER FALK MODEL 22DU SERIAL NO 155-443 JOB NO 8L

MACHINE NO MP4497 LOCATION BB-40-41-0 SHIFT 3

JOB FREQUENCY 3 MONTHS STANDARD TIME .50 HOURS

WORK DESCRIPTION	DATE	APPROVED	TIME HOURS	COST $ LABOR	COST $ MATERIAL
Change oil, grease Coupling	1-10-55	Smith	.50	.92	
Change oil, grease Coupling	4-18-55	Smith	.50	.92	
Replace high speed shaft assembly	5-2-55	Jones	4.25	10.69	71.50
Change oil, grease Coupling	7-10-55	Smith	.50	.92	
Change oil, grease Coupling	10-15-55	Smith	.50	1.02	
Check gears, bearings and seals	1-12-56	Jones	.75	1.96	
Change oil, grease Coupling	1-20-56	Smith	.50	1.07	
Change oil, grease Coupling	4-12-56	Smith	.50	1.02	
Check gears, bearings and seals	6-15-56	Jones	.75	1.96	
Change oil, grease Coupling	7-17-56	Smith	.50	1.02	
Change oil, grease Coupling	10-16-56	Smith	.50	1.08	
Check gears, bearings, replace Coupling grid	12-10-56	Jones	.90	2.67	2.25
Change oil, grease Coupling	1-15-57	Smith	.50	1.08	
Change oil, grease Coupling	4-15-57	Smith	.50	1.08	

INSPECTION AND MAINTENANCE RECORD CARD

Fig. 3

In setting up a preventive maintenance program, it is best to start inspections and adjustments at frequent enough intervals to insure that major breakdowns do not occur just because they are too infrequently done. As experience is gained, the time interval between inspections can be readjusted accordingly.

Figure 1 shows a scheduling board that can be used for efficient operation of a preventive maintenance program. Each machine should be surveyed, as previously mentioned, and the individual items to be checked are listed on a "Maintenance Job Description Sheet" (Fig. 2) which shows the machine number, location, machine make, model and serial number, frequency of check, and the shift that checking is to be done on, plus the normal time allotted for performing the work outlined. At the bottom of the job sheet a space for notes on reference material is also available. A descripion of the work to be performed is given in sufficient detail so that it can be thoroughly understood by the repairman.

Every effort should be made to restrict the work to only one craft per job sheet. If two or more crafts are required to perform the work outlined, then a separate description should be given for each craft involved with appropriate cross referencing between job sheets. This sheet is assigned a number and a letter denoting the craft involved and a round cardboard, metal edged tag or tags with a corresponding number is made for the scheduling board. Different colored tags are used to denote which shift is assigned the work described on each job card.

Each maintenance job description sheet becomes a permanent record in the maintenance files. These sheets are cross indexed on the inspection and maintenance record cards for each machine or piece of equipment (Fig. 3). These cards list all of the repairs and inspections made on a particular machine, the date on which each was performed, the shift, and

by whom it was done. Other pertinent data, such as the time required to perform the job and the labor and material costs, are also entered.

A duplicate copy of each maintenance job description sheet should be made and placed in an enclosed plastic envelope. This copy will be given to the maintenance craftsman who performs the work outlined. When the work is completed the maintenance man will return the job sheet to his supervisor so that it will be available for future use.

The typical maintenance scheduling board (Fig. 1) is divided vertically into four monthly periods of 31 days each. Horizontally, the equipment is listed by category such as air hoists, core blowers, gear reducers, sandmixers, etc. On the right hand side of the equipment list are 12 additional vertical columns, one for each month of the year for jobs scheduled at intervals greater than three months.

The round, colored, cardboard, metal-edged tags, previously explained, are hung on the row of pegs horizontally in line with the proper equipment category. If the work is to be performed during the four-month period on the left hand side of the board, the tag is hung on a peg under the day of the month on which it is to be done. If the work is to be performed later than the four-month period on the left hand side of the board, the tag is placed under the proper month on the right hand side of the board.

As an example, the gear reducer listed on the maintenance job description sheet in Fig. 2, requires that the oil be changed every three months. When this job was scheduled for Jan. 15, the oil was changed in this gear reducer, tag number 8L (L is for lubrication) (Fig. 1) was assigned and moved ahead three months on the maintenance scheduling board to April 15. Since this unit operates on the first and second shift, a green tag is used which designates that the work is to be done by the third shift. On April 15, tag 8L will show on the scheduling board and a job ticket will be made out and given to the lubricator along with the maintenance job description sheet. The lubricator performs the work, records pertinent information, signs the job ticket when completed, and returns it to his supervisor along with the job sheet.

The supervisor then records on the record card (Fig. 3) "Oil changed 4/15/57–Smith, 0.50 hr, $1.08 labor cost" to provide a brief but complete history on the routine inspection and repairs for this machine. The supervisor also moves tag 8L three months ahead on the scheduling board to July 15. Note that the month of July will not appear in the correct left to right order on this board, but as each month is cleared of scheduled jobs, a nameplate for a new month is hung above the vacated month.

If the job frequency in this example was four months instead of three, the tag would be hung on the right side of the board under August until that month appeared on the left when April was cleared. Job frequency and time notations on the backs of the tags allow temporary job deferment decisions to be made by the supervisor in order to balance the daily work load for each maintenance craft.

The maintenance scheduling board, plus the additional record keeping, may seem a bit elaborate to operate, but the useful returns are impressive. The experience of the author's company with a similar scheduling system has resulted in a 90 per cent reduction in maintenance repair cost on gear reducers alone. In addition, the maintenance scheduling board enables us to balance the daily work load for each craft represented.

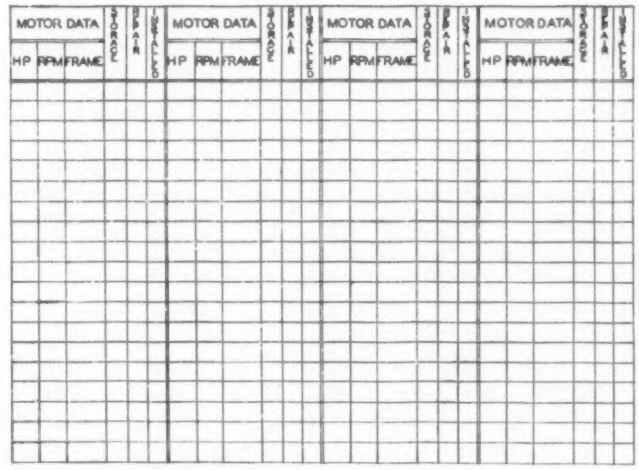


Fig. 4 – Motor location board.

MAINTENANCE RECORDS SHOULD HAVE A USEFUL PURPOSE

Records kept by the Maintenance Department should be only those that will be useful in its function of providing efficient maintenance service to the various departments for which it is responsible.

In addition to the maintenance record cards previously described, a daily record of machine downtime, its cause, and the man hours lost is a useful means of checking the efficiency of the preventive phase of the maintenance program. It can also indicate the need for adding equipment not already included in the present maintenance scheduling system.

A monthly expense record of each machine separated into labor and material costs can be helpful to both the maintenance department and executive management. If the labor and material expended on each piece of equipment by the preventive maintenance program each month shown on the maintenance record card (Fig. 3) accounts for almost the total repair cost of that equipment per month, then the preventive maintenance program is effective. As the maintenance cost keeps increasing with the age of a machine, top management can determine when that machine has outlived its useful life and is no longer profitable to operate.

Records of machine parts, spare units, and materials should also be kept on file in the maintenance office. These records should show the name of the part, the equipment on which it is used, its location, the exact ordering description, and the unit cost.

VISUAL RECORD BOARD FOR SPARE MOTORS

The author's company has successfully used a motor location board (Fig. 4) for several years as a part of our machine record-keeping system. This board includes all motors according to horsepower, type, speed, and frame size that are used in the foundry area. A yellow tag giving the company assigned number, motor rating, the motor location, and date of

installation is made for each motor currently in use. The yellow tags are hung on pegs in the column labeled "Installed", and opposite the proper motor rating given in the column on the left-hand side of the board. Spare motors are assigned a white tag giving the same information as the yellow one except in place of the machine location and installation date, a rack location in the motor storage area is given.

The white tags are hung in the column labeled "Storage" opposite the proper motor rating in the left-hand column. Motors that are out for repair have red tags assigned to them giving the motor rating, where they are being repaired and when they were sent, and are hung in the column labeled "Repair" opposite the proper motor rating.

As the status of a motor changes from installed, to repair, to storage, a different colored tag is made and hung on a peg in the proper column opposite its rating. This board provides a rapid visual means of checking the status of each motor used in the foundry area. This same type of board can also be used for gear reducers and hoists.

ENGINEERING FOR PREVENTIVE MAINTENANCE

The foundry engineering section can make an important contribution to the overall effectiveness of the maintenance program when routine inspection indicates the need for major repairs at relatively short time intervals. Engineering will also be a decided help when certain types of failure or wear are repetitive or when failures occur that result in large man-hour losses of productive labor.

The foundry engineering section should begin its examination of a machine or equipment breakdown by determining whether the part that failed was the cause of the breakdown or the effect of a totally different cause. For example, when a stepped shaft breaks, the effect is the break, but the lack of a sufficient fillet between the steps or lathe tool marks in a sufficiently large fillet, may be the cause of the failure. Always examine part failures and the parts themselves for cause and effect, keeping in mind that the effect is always readily apparent, but the cause frequently is not.

After the real cause of a failure has been determined, the most appropriate remedy should be applied. The remedy can be in the form of design changes, or better material specifications, if the failure is purely a mechanical one. When failures occur due to human error, the most effective remedy is to make certain that the persons responsible for the actual routine inspections and repairs thoroughly understand what they are doing. Maintenance instruction sheets, cross-sectional drawings, assembly drawings, and photographs provide good reference material and visual aids to the maintenance personnel.

Maintenance reference material should be readily accessible and conveniently located for all repairmen. One successful method of making this material accessible in the shop area is by placing it under plastic covers on flip boards in the maintenance shop. In the foundry, reference material in booklet form should be located in a clean place on or near the equipment it applies to, or it can be issued along with the job ticket and maintenance job description sheet.

ENGINEERING STANDARDS ARE AN IMPORTANT PART OF THE INSPECTION FOLLOW-UP

When the engineering section successfully solves one problem it should examine all similar equipment or service conditions to determine if a standard can or should be applied in the design of future installations or the redesign of present ones. Engineering standards, when properly applied, can result in important reductions in both maintenance costs and spare parts inventory costs.

For instance, in our plant we design for certain specified shaft diameters on all belt conveyor and belt elevator installations. The range of shaft diameters specified is sufficient to cover all service conditions yet keep the number of different diameters small. This enables us to always maintain some shaft material of each diameter in stock since each is widely used and always in demand. We also benefit by having fewer inventory dollars invested in bearings and pillow blocks for the same reason.

Standardization of parts, machine components, whole machines, and engineering designs are not only advantageous from the standpoint of saving inventory dollars, but they also pay dividends because the maintenance personnel will have fewer different pieces of equipment to become familiar with, hence they will know each one more thoroughly and be able to do their work more efficiently. Familiarity with equipment means more rapid repairs with less likelihood of errors on the part of the maintenance man.

Engineering standards cannot be strictly adhered to in all cases, but they will serve to focus attention on necessary or desirable exceptions to the established standard. These exceptions may be of such a nature that it is desirable to have them included in the original standard or else set up in an additional standard.

A good set of standards requires thorough study and analysis of both existing equipment and past machine and material failures, plus sound engineering practice, and a liberal amount of plain horse sense.

The first step in establishing engineering standards is to list your present equipment by categories, such as:

1. Power transmission equipment.
2. Conveyor and elevator belting.
3. Cranes and hoists.
4. Electric motors.
5. Electrical controls.
6. Hydraulic equipment.
7. Roller conveyor.
8. Powered conveyor.
9. Sand Mixing equipment.
10. Shakeout machines.
11. Core machines.
12. Molding machines.
13. Oven and furnace equipment.
14. Dust collectors and fans.
15. Hand tools.
16. Material handling equipment.
17. Blasting machines.
18. Grinders.
19. Tumblers.

Then take each category separately and break it down into its component parts, such as shown in Table 1.

Now make a survey of all of the flexible couplings used in your foundry. For each coupling, list the manufacturer, model, size, bore, keyway, price, and

location where it is used. The first thing that will be apparent when this survey is completed is whether there are different keyway sizes in otherwise identical couplings. This can be taken care of by re-designing the shafts on which they are used. In some special cases, a stepped key may be more practical. Standardization of shaft sizes, as previously mentioned, should be done at the same time keyway sizes are being changed.

Next, group all of the couplings together that are of identical bore, keyway, and transmission capacity, but made by different manufacturers. Select one or two types of couplings that will best suit all of the service conditions throughout your foundry and standardize on them. If the price differential is small between adjacent sizes of the same coupling, consider using fewer sizes to further reduce the spare parts inventory required.

This procedure can be followed for all types of equipment, but it is readily apparent from the above example that the standardization of flexible couplings will set off a chain reaction which can affect every item listed under "Power Transmission Machinery." Because of this chain reaction, standards must be set up on paper first, and applied gradually as equipment breaks down, wears out, or is replaced. This process may take some time to complete, but the results, in terms of reduced inventories and increased maintenance efficiency more than warrant the effort.

In the author's company, this standardization program has been going on for about 15 years. It is not yet completed, because about the time one phase is done an improved design or new product is introduced that makes it more economical to revise one or more of our standards. If standards were not applied in this manner, the door to future improvements would be tightly shut. Resistance to change when better methods or improved products are discovered is the one pitfall to be avoided in a standards program.

MAINTENANCE IN THE MANAGEMENT ORGANIZATION

The organization of the maintenance and engineering functions in relation to each other and their location in the management structure determines, in a large measure, how effectively they can contribute to the overall plant efficiency. Figure 5 illustrates an organizational arrangement designed to give maximum effectiveness.

The foundry manager has the responsibility and the necessary authority to make sure that the Planning and Production Departments get the engineering and maintenance services that they need to function efficiently. The foundry engineer has the responsibility of providing maintenance service to each shift and the design group necessary to give the Maintenance Department the technical assistance it needs.

TABLE 1 – SAMPLE OF CATEGORY BREAKDOWN

POWER TRANSMISSION MACHINERY	
1. Flexible couplings	5. Pulleys
2. Reduction units	a. V-belt
a. Fixed reduction	b. Flat belt
b. Variable speed	c. Conveyor
3. Shafts	6. Sprockets
4. Bearings	7. Chain
	8. Clutches

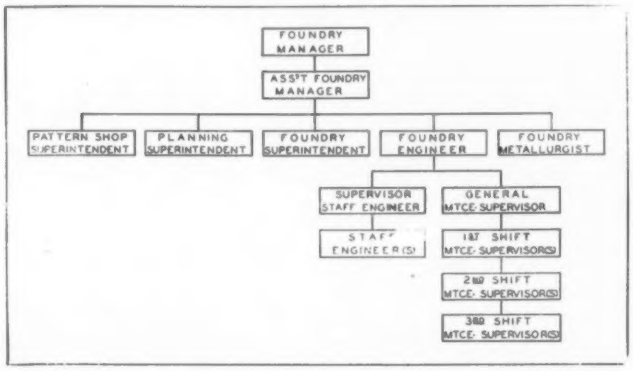


Fig. 5–A management organizational structure for preventive maintenance.

Under the foundry engineer is the general maintenance supervisor who has charge of all three shifts in the Maintenance Department, but each shift supervisor is also responsible for providing for the needs of both the preceding and succeeding shifts, thus assuring continuity of operation.

It is essential that each shift maintenance supervisor thoroughly understands the needs, capabilities, and problems of the other two shifts. The resultant overall operation of the Maintenance Department should be improved by periodically rotating the foreman from the first, to the second, to the third, and back to the first shift. If there are two or more foremen on each shift, rotate half of them in one order and half in the other, but stagger the rotation to assure continuity. Shift rotation gives each foreman a greater perspective of the problems involved and minimizes "passing the buck."

SUMMARY

The old saying that, "A chain is only as strong as its weakest link," is certainly true in a foundry operation. In order to remain competitive within the industry, foundries are turning more and more to increased mechanization and automation. The industry, as a whole, is then better able to be competitive with other methods of manufacture. Thus, the maintenance program must be a strong link in the foundry operational chain, because where competition is keen the cost of poor maintenance in terms of lost production, scrap, rework, and idle manpower can be enough to change the accounting ledger color from black to red.

YOUR FOUNDRY AND PREVENTIVE MAINTENANCE

By

C. E. Fausel*

Preventive maintenance might be defined as a determination of what can be done economically to prevent equipment breakdowns before they occur and to put the greater portion of maintenance work on a planned basis. In other words, a preventative maintenance program consists of doing repair work on a pre-determined schedule rather than when equipment breakdowns demand that it be done.

Foundry equipment, left to its own devices, seems to have a fiendish ability to do one of the following:

1. Fail five min after the starting whistle blows.
2. Shear a 5-cent screw in the first of a series of 5 machines.
3. Break down so that maintenance work is required on Memorial Day, Labor Day, Christmas, or New Year's Day.

With competition becoming keener each day, we foundry people have a dual challenge of improving our quality while cutting the manufacturing cost of our product. In the last few years, most of our companies have grown in size, most of our processes have become more complex, and I am sure that we have all added some form of mechanization which a decade ago we felt could never exist. We all recognize the importance of conversions as a source of business, and perhaps each company represented here could be working just a little harder in this area; however, as we know, additional conversion business means more equipment and mechanization, and this in turn requires additional maintenance.

Maintenance and mechanization are rapidly becoming two of the most important terms, not only in the foundry, but in all industry, and the importance they hold today is trivial compared with what they will represent five years from now. Whether your plant employs 10 people or 1,000 people, if you are to meet the challenge in the coming years, you must become familiar with these terms and understand just what they represent.

Let us consider for a moment a large company, not a large producer of castings, but whose thinking parallels ours in many ways. At the present time this company employs some 220,000 people, and they estimate that by 1964 they will need 450,000 workers, or a 100 per cent increase in order to meet production demands at their present level of output; yet the best they can hope for is an 11 per cent increase in the national labor force.

Since this same 11 per cent figure applies to the foundry industry, it appears that the only solution is mechanization. As we mechanize, we can realize a savings from our investment only if we keep the equipment running at all times with the least amount of expense. This, of course, requires maintenance; not the bailing wire type we have all been used to in the past, but maintenance by skilled trades people who are well-trained, well-equipped, and above all, supervised by specialists.

At the present time, about 8 per cent of all workers in industry are maintenance workers. As mechanization increases, so will demands for maintenance and maintenance personnel. In the petroleum industry for example, maintenance workers represent 50 per cent of the total employment.

In order to give you a clear-cut picture of preventive maintenance, it will be necessary to tell you how the author's company approaches this activity, what has been started in this field in order to keep the equipment effective, and what each employee can do to meet the challenge ahead. As foundry operations go, the plant in Danville is quite large. You may say to yourself, "Well, this is impractical for our size foundry"; however, I believe that if you look at the basic thinking and principles utilized in the author's company's program, I am sure you will see that they are practical for any size foundry.

PROGRAM INITIATION

Before going any further, I would like to tell you a little bit about the organization. The Danville plant is one of three plants comprising this foundry division. The other two plants are located at Saginaw, Mich. and Defiance, Ohio. At the Danville plant there are two foundries, one pouring gray iron and the other malleable iron, and this operation necessitates two production shifts and three maintenance shifts each day.

A few years ago, the maintenance department was found becoming more and more like a fire department, in that it was continually running to breakdowns, repairing equipment on production shifts, and on many occasions, just in time to run to the

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next breakdown. As you know, in a situation such as this, you get little constructive work done and you usually end up with a foundry that has more downtime than productive time.

In order to stop this merry-go-round, a controlled maintenance or preventive maintenance section was instituted within the department. The necessary administrative equipment was set up, and an additional foreman and two clerks were hired for the section. Naturally, mistakes were made in the beginning, but it was not long before it was seen clearly that this method of operating and controlling of the maintenance department from an administrative section within it was beginning to pay dividends. Downtime decreased to the point where there actually was time on the third shift to change equipment before it broke down.

In setting up such a program, there were many areas that were necessary to cover. So, in order to get something workable, the controlled maintenance program was divided into five areas, in which it was felt the most immediate gains could be received. The five areas included:

1. A lubrication program.
2. An air cylinder program.
3. A truck program.
4. An inspection program.
5. Department service.

THE LUBRICATION PROGRAM

Lubrication has been probably the most over-looked operation performed by a maintenance department, and yet it is one of the most important. We all know that to keep two sliding surfaces from direct contact an oily film must be present, yet each year many of us spend thousands of dollars on new bearings and machine downtime in our plants because we have failed to set up a complete lubrication program to provide this basic oily film.

For a good lubrication program, the author's company feels that you should do these three things:

1. Set up a lubrication file.
2. Provide good clean greasing equipment for your greasers.
3. Sell the greasers on the importance of their jobs.

In setting up the lubrication file, first survey all of the equipment, and then list each main piece of equipment and sub-list its component parts. To make the file workable, it was necessary to code the types of greases used, the days of the week, and the individual greaser (Fig. 1). In Fig. 2 you can see what the master lubrication file looks like, and of course, this file is used to make up the greasers' schedule. As you can see, each component is listed on a slide-out strip which allows new equipment to be inserted into the file.

Figure 3 represents the actual work sheet or routing which each greaser is given at the beginning of his shift. By following this sheet, he cannot miss equipment, or grease it improperly. This system, of course, takes considerable time and effort to establish, but once in use it is as foolproof as the dip-stick in your automobile crankcase. If you heed what it says, you cannot burn out a bearing.

GREASERS EMPLOYED BY PLANT		EXAMPLE:	
NO. 1 GREASER	⊜	○⊜⊗●⊕	28 2-15
NO. 2 GREASER	⊗	CIRCLE	- Denotes the day of the week
NO. 3 GREASER	●	28	- Denotes the type of oil or grease
"A" UNIT MAN	⊕	2	- Denotes the number of zerks
		15	- Denotes the number of pumps

Fig. 1

333-7B UNLOADING APRON CONVEYOR			
HEAD BEARINGS	○○⊜○⊕	28	2-15
TAIL BEARINGS	○○⊜○⊕	28	2-15
WHEELS	○⊗○⊗○	25	SPRAY
SPROCKETS (DRIVE)	●○⊜○⊕	25	SPRAY
CHAIN (DRIVE)	●○⊜○⊕	25	SPRAY
333-8C BELT UNDER SAND STORAGE BINS			
HEAD BEARINGS	○○⊜○⊕	28	2-15
TAIL BEARINGS	○○⊜○⊕	28	2-15
ROLLERS AND IDLERS	○○⊜○⊕	28	2-3
SPROCKETS (DRIVE)	●○⊜○⊕	25	SPRAY
CHAIN (DRIVE)	●○⊜○⊕	25	SPRAY
333-10A WET SAND ELEVATOR			
HEAD BEARINGS	○○⊜○⊕	28	2-15
TAIL BEARINGS	○○⊜○⊕	28	2-15
333-12C DRY SAND ELEVATOR			
HEAD BEARINGS	○○⊜○⊕	28	2-15
TAIL BEARINGS	○○⊜○⊕	28	2-15
333-14 INCLINE BELT FROM ELEVATOR			
HEAD BEARINGS	○○⊜○⊕	28	2-15
TAIL BEARINGS	○○⊜○⊕	28	2-15
ROLLERS AND IDLERS	○○⊜○⊕	28	3-3

Fig. 2

MONDAY
"C" SHIFT LUBRICATION SCHEDULE-NO. 1 GREASER

Equipment	Type of Oil or Grease	Zerks-Pumps	Initial
333-7B Unloading Apron Conveyor			
Head Bearings	28	2-15	
Tail Bearings	28	2-15	
Wheels	25	Spray	
Sprockets (Drive)	25	Spray	
Chain (Drive)	25	Spray	
333-8C Belt Under Sand Storage Bins			
Head Bearings	28	2-15	
Tail Bearings	28	2-15	
Rollers and Idlers	28	2-3	
Sprockets (Drive)	25	Spray	
Chain (Drive)	25	Spray	
333-10A Wet Sand Elevator			
Head Bearings	28	2-15	
Tail Bearings	28	2-15	
333-12C Dry Sand Elevator			
Head Bearings	28	2-15	
Tail Bearings	28	2-15	
333-14 Inclined Belt From Elevator			
Head Bearings	28	2-15	
Tail Bearings	28	2-15	
Rollers and Idlers	28	3-3	

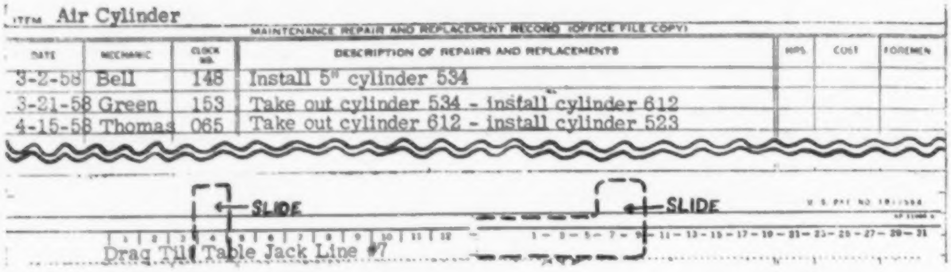
Clean all zerks thoroughly before applying grease gun to fittings and remove excess grease to prevent fire hazards.

Fig. 3

AIR CYLINDER FAILURE REPORT

Cylinder Number: 502
Date Removed: 4-4-58
Location: 5 & 6 Conveyor Lip Jack Cylinder
Reason For Removal: Blowing By and One Stay Rod Broke
Repair Data: 2-4" Leathers
1-Tie Rod and 1/2 Hex Nut
1-Back Head
Replacement Cylinder's Number: 510
Millwright's Initials:

Fig. 4


ITEM Air Cylinder

MAINTENANCE REPAIR AND REPLACEMENT RECORD (OFFICE FILE COPY)

DATE	MECHANIC	CLOCK NO.	DESCRIPTION OF REPAIRS AND REPLACEMENTS	HRS.	COST	FOREMEN
3-2-58	Bell	148	Install 5" cylinder 534			
3-21-58	Green	153	Take out cylinder 534 - install cylinder 612			
4-15-58	Thomas	065	Take out cylinder 612 - install cylinder 523			

SLIDE SLIDE

Drag Tilt Table Jack Line #7

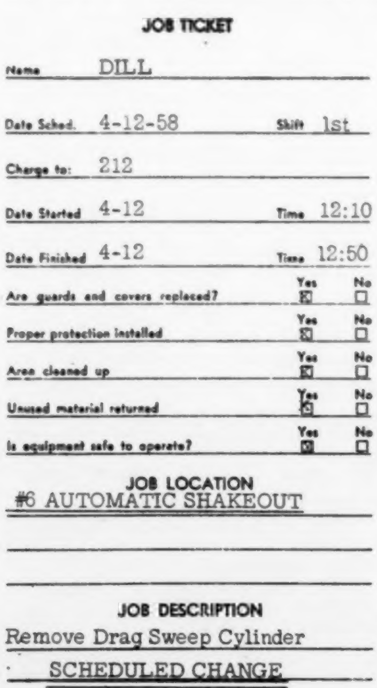
Fig. 5

THE AIR CYLINDER PROGRAM

At the author's company much of the mechanized equipment is powered by air cylinders. And even before the preventive maintenance program was instituted, it was recognized that here was the weakest link in the production chain. Possibly, in some of your plants, you too may have a similar item that invariably is your weak link, and if you do, it is suggested that the following procedures be used as guides as a means of strengthening your production chain.

Figure 4 is a cylinder failure report. Not only is it made out each time a failure occurs, but it is also used at the beginning of a program as information on which you can base the "life-span" or "change-out" period on the equipment it represents. The author's company also uses it to prove or disprove the accuracy of the "change-out" period, simply by the fact that if failures continue the "change-out" period is too long. If there is never a failure report, possibly the period is too short.

Figure 5 shown above, is an index card used to follow the changes on a piece of equipment, and also used by the maintenance clerk to schedule the changes. Note on the bottom of the card the numbers 1-12 which indicate the month and the numbers 1-31 which indicate the day. The tab, of course, tells when the next scheduled change is due. Using this information, the clerk makes out a job ticket as shown in **Fig. 6**, which is the "action" necessary to prevent breakdowns and a basis on which the maintenance work is planned.


JOB TICKET

Name DILL

Date Sched. 4-12-58 Shift 1st

Charge to: 212

Date Started 4-12 Time 12:10

Date Finished 4-12 Time 12:50

Are guards and covers replaced? Yes ☒ No ☐

Proper protection installed Yes ☒ No ☐

Area cleaned up Yes ☒ No ☐

Unused material returned Yes ☒ No ☐

Is equipment safe to operate? Yes ☒ No ☐

JOB LOCATION

#6 AUTOMATIC SHAKEOUT

JOB DESCRIPTION

Remove Drag Sweep Cylinder

SCHEDULED CHANGE

Fig. 6

THE TRUCK PROGRAM

Regardless of how many conveyors the author's company uses, or how mechanized the company becomes, we feel sure that for many years plants will still be dependent on trucks as the prime source of movement for raw materials and products. Truck maintenance is reportedly the most costly of all repair work in many plants, and in order to reduce this cost, it is necessary to keep these trucks carrying a payload throughout the operating shifts. To do so, inspections must be performed and minor components replaced periodically on a set schedule before major breakdowns occur.

One of the most preventive measures is the scheduled oil change. It is very difficult, if not impossible, to keep an engine from "breathing" in dirt, and the

TRUCK INSPECTION PROGRAM 1958

Date		Truck				Date		Truck			
Jan.	2	30°	13°	23	19	Feb.	3	30°	13°	23	19
	3	1°	6°	34	2		4	1°	6°	34	2
	6	14°	5°	20	38		5	14°	5°	20	38
	7	33°	12°	7	21		6	23°	12°	7	21
	8	18°	11°	24	62		7	18°	11°	24	62
	9	58°	4°	27	29		10	58°	4°	27	29
	10	22°	16°	28	36		11	22°	16°	28	36
	13	31°	8°	35	64		12	31°	8°	35	64
	14	15°	17°	9	37		13	15°	17°	9	37
	15	63°	3°	25	40		14	63°	3°	25	40
	16	23°	19°	30	13		17	23°	19°	30	13
	17	34°	2°	1	6		18	34°	2°	1	6
	20	20°	38°	14	5		19	20°	38°	14	5
	21	7°	21°	33	12		20	7°	21°	33	12
	22	24°	62°	18	11		21	24°	62°	18	11
	23	27°	29°	58	4		24	27°	29°	58	4
	24	28°	36°	22	16		25	28°	36°	22	16
	27	35°	64°	31	8		26	35°	64°	31	8
	28	9°	37°	15	17		27	9°	37°	15	17
	29	25°	40°	63	3		28	25°	40°	63	3
Mar.	5	30°	13°	23	19	Apr.	1	25°	40°	63	3
	6	1°	6°	34	2		4	30°	13°	23	19
	7	14°	5°	20	38		7	1°	6°	34	2
	10	33°	12°	7	21		8	14°	5°	20	38
	11	18°	11°	24	62		9	33°	12°	7	21
	12	58°	4°	27	29		10	18°	11°	24	62
	13	22°	16°	28	36		11	58°	4°	27	29
	14	31°	8°	35	64		14	22°	16°	28	36
	17	15°	17°	9	37		15	31°	8°	35	64
	18	63°	3°	25	40		16	15°	17°	9	37
	19	23°	19°	30	13		17	63°	3°	25	40
	20	34°	2°	1	6		18	23°	19°	30	13
	21	20°	38°	14	5		21	34°	2°	1	6
	24	7°	21°	33	12		22	20°	38°	14	5
	25	24°	62°	18	11		23	7°	21°	33	12
	26	27°	29°	58	4		24	24°	62°	18	11
	27	28°	36°	22	16		[illegible]	27°	29°	58	4
	28	35°	64°	31	8		28	28°	36°	22	16
	31	9°	37°	15	17		29	35°	64°	31	8
							30	9°	37°	15	17

°Denotes lube and inspection.

Fig. 7

only damage preventive measure we can take in this area is a frequently scheduled oil change. Figure 7 shows a schedule that facilitates the timely arrival of trucks at the garage area. If, in Fig. 7 you will follow truck No. 30, you will see that it is scheduled for a complete inspection once a month, and a lube and oil change twice a month. Figure 8 is the check sheet used by the mechanics to inspect the major component of the truck. These items are not picked at random, but are in a priority order, according to the number of failures occurring during a one year period.

Figure 9 is a check sheet kept on the truck and used as a daily inspection by the individual truck driver. This sheet is turned into the maintenance department weekly. Figure 10 shows a typical job ticket, indicating job performed, time taken, and material used. This information is transferred each month to a truck record card, as in Fig. 11, which is maintained to analyze cost and breakdowns, and which can also be used to justify the purchase of new equipment.

THE INSPECTION PROGRAM

A good thorough inspection system is the foundation for any successful preventive maintenance program. Basically, such a program should follow this general pattern:

1. Set up a scheduling system.
2. Provide job instruction forms.
3. Maintain records.

A big help in setting up a scheduling system is a card index file. The system should be simple and compact great quantities of information in a small

MONTHLY SCHEDULED TRUCK ELECTRICAL MAINTENANCE

Truck Inspection

Date	4-3-58
Truck Number	#6-110
Hoist Controller	O.K.
Hoist Motor	Brushes Replaced
Travel Controller	O.K.
Travel Motor	O.K.
Horn	Wires Replaced
Main Generator Brushes, Volt	O.K.
Foot Switch	O.K.
Limit Switch	Replaced
Battery Charger	O.K.
Motor Starter	O.K.
Battery	O.K.
Wiring	Horn Wires Insulation-Worn Off

MONTHLY SCHEDULED TRUCK MECHANICAL MAINTENANCE

Truck Inspection

Date	4-3-58
Truck Number	#6-110
Steering	O.K.
Brakes	New Shoes
Axle	O.K.
Hoist	O.K.
Fan	O.K.
Radiator	O.K.
Platform	O.K.
Spring Hanger Bolts	O.K.
Points Plugs	
Generator	O.K.
Frame	O.K.
Controls	O.K.
Hour Meter	O.K.

Fig. 8

WEEKLY TRUCK REPORT

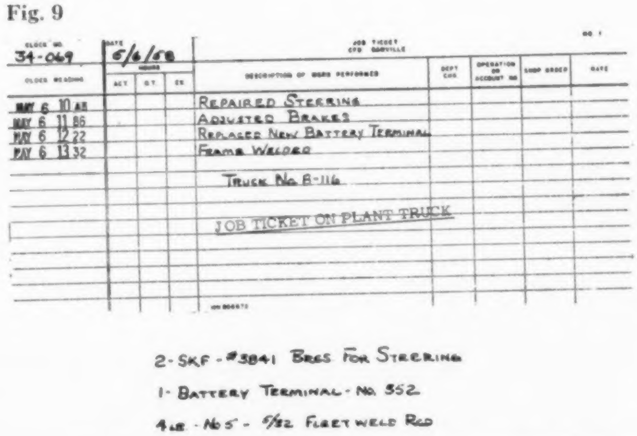
DATE 4-18-58 TRUCK #30 DATE 4-25-58

Check	Mon 1	Mon 2	Mon 3	Tue 1	Tue 2	Tue 3	Wed 1	Wed 2	Wed 3	Thur 1	Thur 2	Thur 3	Fri 1	Fri 2	Fri 3	Sat 1	Sat 2	Sat 3	Sun 1	Sun 2	Sun 3	Comments
Oil	OK	OK	OK	OK	OK	OK	OK	OK	OK													
Water	OK	OK	OK	OK	OK	OK	✓	✓	OK													Radiator Leaks
Governor	OK	OK	OK	✓	OK	OK	OK	OK	OK													Sticking
Steering	✓	in shop	OK	OK	OK	OK	OK	OK	OK													Steers hard
Brakes	OK	OK	✓	OK	OK	OK	OK	OK	OK													Adjust Brakes
Hangers & Shackles Bolts	OK	OK	OK	OK	OK	OK	OK	OK	OK													
Controller	OK	OK	OK	OK	✓	OK	OK	OK	OK													
Lift	OK	OK	OK	OK	OK	OK	OK	OK	OK													
Damage to Truck	none	none	none	none	none	none	none	none	none													
Employee Sign	E.F.	R.S.	M.T.	E.F.	R.S.	M.T.	E.F.	R.S.	M.T.													
Foreman Sign	J.J.	J.R.	W.H.	J.J.	J.R.	W.H.	J.J.	J.R.	W.H.													

General Foreman__________

Superintendent__________

Fig. 9


CLOCK NO. 34-069 DATE 6/6/58 JOB TICKET

CLOCK READING	DESCRIPTION OF WORK PERFORMED
MAY 6 10 AE	REPAIRED STEERING
MAY 6 11 86	ADJUSTED BRAKES
MAY 6 12 22	REPLACED NEW BATTERY TERMINAL
MAY 6 13 32	FRAME WELDED
	TRUCK No. B-116
	JOB TICKET ON PLANT TRUCK

2-SKF-#3841 BRGS FOR STEERING

1-BATTERY TERMINAL-No. 552

4 LB-No 5-5/32 FLEETWELD ROD

Fig. 10

ITEM Truck No. 28

MAINTENANCE REPAIR AND REPLACEMENT RECORD (OFFICE FILE COPY)

DATE	MECHANIC	CLOCK NO.	DESCRIPTION OF REPAIRS AND REPLACEMENTS	HRS.	COST	FOREMEN
4-4-58	Morgan	069	Grease, change oil and filter, install hoist leather, clean air cleaner.	2.9	$6.38	

Fig. 11

efficient space. By reading the indicator tabs each day an unskilled clerk should be able to schedule many skilled people to their jobs of preventing downtime. The system should be a little bit like the old method of tying a string around your finger so that you won't forget that tomorrow is your wife's birthday.

After a scheduling system has been established, the following types of job instruction forms are used. In Fig. 12 you see a typical routing sheet issued by the preventive maintenance office to perform an in-

PREVENTIVE MAINTENANCE INSPECTION ROUTING

All Driers — Mechanical

Time Required 20 Minutes — Date ____

Location ____ — Check Only Items Inspected When Used On Operating Shift

	✔ Off	Remarks
1. Check speed reducer at high oil level plug for oil		
2. Check speed drive bearings for wear and lubrication		
3. Check trunnion bearings for wear and lubrication		
4. Check guide roller and bearing for wear and lubrication		
5. Check drier to see that it is running properly on the trunnion & guide rollers		
6. Check exhaust fan bearings for wear and lubrication		
7. Check feeder for rubbing on drier (if used)		
8. Check sealing ring at heat end		
9. Check ring gear and driver gear for mesh and wear		
10. Check for leaks in drum		

Guard condition ____

Inspected by ____

Turned in to

Fig. 12

WEEKLY LOAD READINGS ____

DATE ____

EQUIPMENT	A PHASE	B PHASE	C PHASE	AVERAGE
#5 Cope Shaker				
#5 Power Rolls				
#5 Drag Shaker				
#6 Flask Return Conv.				
#6 Elevator				
#6 Mold Line				
#6 Cope Shaker				
#6 Power Rolls				
#6 Drag Shaker				
C Unit Mag. Belt				
#7 Flask Return Conv.				
#7 Elevator				
#7-1/2 Elevator				
#7 Mold Line				
#7 Cope Shaker				

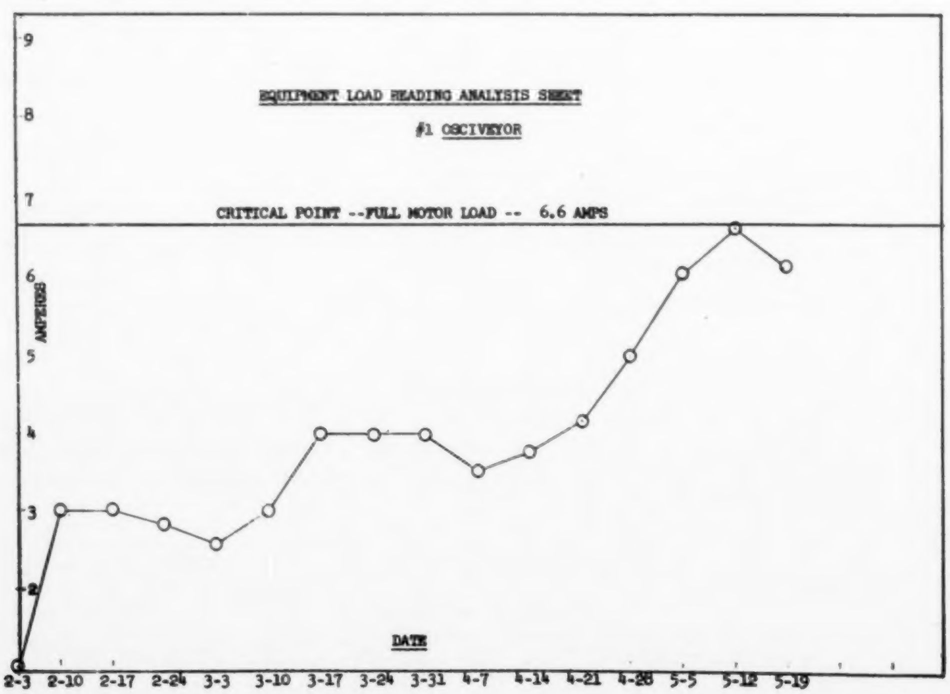
PARTIAL LIST OF WEEKLY LOAD READINGS

Other Equipment Includes:

#1 Conveyor	#1 Power Rolls
#2 Conveyor	#1 Drag Shaker
#3 Conveyor	#2 Flask Return Conv.
#4 Conveyor	#2 Elevator
#5 Conveyor	#2 Mold Line
#6 Conveyor	#2 Cope Shaker
#7 Conveyor	#2 Drag Shaker
#8 Conveyor	#2 Power Rolls
#9 Conveyor	#3 Flask Return Conv.
#10 Conveyor	#3 Elevator
#11 Conveyor	#3 Mold Line
#12 Conveyor	#4 Mold Line
#13 Conveyor	"A" Mag Belt
B Unit #1 Conveyor	"B" Mag Belt
B Unit #2 Conveyor	#5 Flask Return
B Unit #3 Conveyor	#5 Elevator
#5 and #6 Shakeout Conveyor	#5-1/2 Elevator
#7 and #8 Shakeout Conveyor	#5 Mold Line
#1 Flask Return	#7 Cope Shaker
#1 Elevator	Hort. Oven
#1 Mold Line	Buckets
#1 Cope Shaker	Mall. Hort. Oven

Fig. 13

Fig. 14



OIL CHANGE RECORD

DATE	INITIALS	DATE	INITIALS	DATE	INITIALS	DATE	INITIALS	DATE	INITIALS
3/21/58	PS								
4/1/58	PS								

3/21/58 4 gallons Opaline SAE 140
4/1/58 - 2 gallons Opaline SAE 140

Inspections:
Jan. PS - ok
Feb. PS - ok
Mar. PS - ok
Apr. PS - Bad high speed shaft
May
June
July
Aug.
Sept
Oct.
Nov.
Dec.

SPEED REDUCER INSPECTION
SPEED REDUCER RECORD

MAKE	TYPE	RATIO	SERIAL NO.	EQUIP. NO.
Palmer Bee	HT-22	294-1	A-11040	215-15 A
SERVICE FACTOR	H. P. RATING	INPUT R.P.M.	OUTPUT R.P.M.	TORQUE
HI SPEED COUPLING	LOW SPEED COUPLING	HI SPEED SHEAVE	LOW SPEED SHEAVE	
V-BELT	TYPE OIL	QUANTITY		

REMARKS	DATE		LOCATION
	3-21	58	No. 1 Kiln Charge Pusher
High speed shaft bearings ordered on	4-7	58	Taken to shop for repairs
P. O. No 220691			

Fig. 15

MOTOR FAILURE REPORT

Motor Data
H.P. 15 Frame 336 Speed 1800
Serial # 987653 Model A
Mfg. Delco Amperage 6.9

Location where used: Gray Iron Sand Muller (110)
Cause of failure: Single Phase
Size of thermal overloads in starter: B 28
Did overloads kick out?: Yes
Did fuses blow?: Yes
Condition of motor bearings: Good
What amperage does the new motor pull?: 18
Size of thermal overload relays now in starter: Same
Motor data on motor installed:
H.P. 15 Frame 523 Speed 1800
Serial # 987654 Model A
Mfg. Delco Amperage 6.9

Time of failure: 7:20 p.m. 4-9-58
Remarks: Single phase to open circuit between disconnect and motor.

Fig. 16

MOTOR RECORD — Induction Motor

STYLE OR MODEL	TYPE	FRAME	POLES	H.P.	SYN. SPEED	SERIAL NO.	EQUIP NO.
		C-6085S		125		X-13677-A2	

MANUFACTURER	FORM	PHASE	VOLTS FUSED	AMPERES	SPEED FULL LOAD	TEMP. RATING
Reliance	F	3	440	155.0		

PULLEY — KEY WAY — PINION — BRUSHES — COUPLING
INBOARD BR'G NO — OUTBOARD BR'G NO — SHAFT DIA.

K W LOAD	DATE	AMP. LOAD	K W LOAD	DATE	AMP. LOAD

DATE	LOCATION	DATE	LOCATION
4-1-58	South Muller Grey Iron		
4-7-58	Repair Area		

Fig. 17

spection on sand driers. As you can see, it does not leave any part of the equipment to "chance inspection". Figure 13 is called "load-reading" inspection and essentially is an electrical inspection that tells a great deal about both the electrical and the mechanical condition of the equipment. The author's company has a list of all of the critical equipment in the plant, and each week, with a snap-on ammeter, the load that the equipment operating motors are pulling is read. This information is plotted on a graph, as in Fig. 14, and is analyzed on a weekly basis. If the load rises continually a mechanical inspection is made immediately, and in many cases a mechanical malfunction is found and repaired before the equipment breaks down.

Records are kept on data found through all inspections. A typical record card is shown in Fig. 15, which here represents a record of oil changes, inspections, and equipment location. Figure 16 is a motor failure report which is made out each time a motor is changed due to malfunction. This record is kept in conjunction with a motor record card as shown in Fig. 17 and is maintained on every motor in the plant. This information tells everything about the physical aspects of the motor, plus a history of its use.

DEPARTMENTAL SERVICE

This phase of the preventive maintenance program is essentially just what the title indicates. This is a service department within a service department. The two main objectives here are to provide administrative service and follow-up on equipment, experimental tests, etc. This section is of great value to the maintenance department, as it eliminates the paper work, "red-tape", and much of the follow-up that usually keeps a maintenance supervisor in the office rather than out in the plant where he is of the most value to the organization.

This overall five step program has been in effect at the author's company for approximately three years, and of course, it is continually being modified to fit changing needs. Two benefits have come from the program: 1) There has been a substantial decrease in equipment downtime, and, 2) Maintenance cost per ton of castings produced has decreased.

We believe that there are very few of us who can truly visualize what lies ahead in our foundry industry, but I am sure that our ever increasing plant mechanization will be accompanied by tremendous maintenance requirements. I am certain that each of us recognizes the fact that we must further mechanize in the coming years, and in order to facilitate the mechanization, we will have to have a well-trained maintenance organization, one that uses the controlled principles of preventive maintenance.

THE EFFECT OF TEMPERATURE AND ATMOSPHERE ON IRON-SILICA INTERFACE REACTION

By

G. A. Colligan, L. H. VanVlack, and R. A. Flinn*

ABSTRACT

The quality of the surface as well as the dimensional accuracy of a casting depends upon the extent of the reaction between the metal and the mold material. Some of the variables affecting the reaction are the compositions of metal and sand, pouring temperature and casting cooling rate, metal pressure, and the mold atmosphere.

In this investigation, compacts were made of pure iron and quartz sand and subjected to different atmospheres in which the degree of oxidation was controlled by selecting the CO_2/CO ratio. The specimens received microscopic and x-ray diffraction examination.

The data indicate that the mechanism of mold attack in this sytem is as follows:

Iron is oxidized at the mold surface, forming a separate, oxide liquid which wets the silica sand in the mold. This liquid phase penetrates into the pores of the mold. Silica is soluble in this oxide liquid to about 50 weight per cent. Solution of the silica enlarges the pores in the sand. This enlargement permits the molten iron to penetrate the mold at low pressures although the iron does not wet the silica sand. The depth of penetration into the sand by the iron depends upon the length of time at elevated temperatures and the severity of oxidation.

If the CO_2/CO ratio is maintained at a low level, only quartz grains and iron are present. No iron silicate melt is observed and no penetration occurs at low pressures because the iron does not wet the silica.

INTRODUCTION

The mold-metal interface reaction is certainly not a new phenomenon to the foundryman. For many years it has been understood that there can be a reaction between metal and the mold which can lead to burnt-on sand, metal penetration, surface roughness, casting porosity, and dimensional inaccuracy. Many good practical solutions involving mold washes, special additives to both mold material and metal, variations in gating technique, and pouring temperature have been developed empirically to meet situations as they developed.

However, there is still no general solution because there is not an accurate quantitative understanding of the problem. The need for this understanding is becoming more acute because new molding materials, such as those used in shell molding and CO_2-sodium silicate sand core-blowing techniques, are being developed. Each new method requires another empirical solution, whereas, if the basic reactions could be controlled, much effort could be saved. Also just as each molding material requires a new cut and try solution, each new alloy calls for a separate effort to improve its cast surface quality.

With modern advances in theory and practice in ceramics, organic and physical chemistry and in metallurgy, it appears that it is time for a concerted attack to evaluate the role of different variables in the interface reaction. Much interesting work has already been done and is well summarized in a current review by Murton and Gertsman.[1] Those features of previous work which bear directly on this investigation will be mentioned briefly.

The early experiments of Caine[2] involved immersing sand specimens in liquid metal. More attention was given to penetration than to the mold-metal interface reaction, and it was concluded that geometric effects such as large void size were of major importance. Dietert[3] pointed out some of the effects of varying mold atmosphere. Savage and Taylor[4] observed the effect of mold atmosphere upon the reaction products present at the surface of steel pins inductively melted in sand.

X-ray diffraction determinations showed that fayalite, Fe_2SiO_4, was present at the interface after cooling. Hydrogen or nitrogen atmospheres prevented fayalite formation. Giller[5] concluded that the fayalite crystallized from a liquid melt when cooling was not too rapid. More rapid cooling produced an iron silicate glass. Petersson[6] also conducted an examination of interface reaction products, and found that increased carbon and aluminum in the metal decreased penetration.

Hoar and Atterton[7] found that the pressure required to initiate penetration was proportional to the surface tension of the metal. For example, tin (500 dynes/cm), required a pressure of about 15 cm of Hg. Copper (1000 dynes/cm) needed a pressure of 30 cm of Hg to initiate penetration into a normal mold sand.

From the foregoing review of the literature and preliminary experiments by the authors, it appears

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that two mechanisms operate to break down the sand-metal interface and thereby injure both the casting surfaces and dimensional tolerances.

Mechanical Variables

Penetration of metal can be produced in all but impermeable molds by applying sufficient pressure. This can be done by increasing the metal head or by applying a vacuum in the sand. With finer voids, a greater pressure differential is needed. Fine grain size and hard ramming therefore reduce penetration.

Chemical Variables

Small changes in analysis of the metal (Al, C), or in mold atmosphere, resulted in changes in the amount of burnt-on sand and metal penetration. Increased penetration occurred with higher metal temperature. Although these effects have generally been ascribed to mechanical influences such as decreased metal viscosity, the work of this investigation indicates that higher temperatures also accentuate chemical reactions.

The present work is concerned chiefly with the evaluation of the chemical mechanisms leading to reactions between the metal and the mold materials. This is a major problem and, in the authors' opinion, is equally as important as the mechanical metal penetration in all but large castings. Furthermore, it was desired to evaluate sand attack at temperatures below the melting range of steel as well as above these temperatures.

To remove the effects of metal pressure and permit the separate study of the chemical variables, the following procedure was developed.

PROCEDURE

The system iron-silicon-oxygen-carbon was chosen for study because iron and silica and a gaseous atmosphere are the principal reactants in the mold interface reactions. Once the mechanism of a simple system is known, the effects of additional elements may be explored.

Each specimen consisted of a mixture of reagent grade iron powder and quartz grains (Ottawa silica sand, 40-60) contained in platinum envelopes. Heating was done in a horizontal globar furnace. The degree of oxidation was controlled by premixing CO and CO_2 gases in desired ratios. The partial pressure of oxygen may be calculated from the known equilibrium constant of the equation $CO + 1/2\ O_2 = CO_2$

In addition to providing a convenient control of the oxidation level, both CO and CO_2 are present in mold atmospheres. Furthermore, other atmospheres containing hydrocarbons and oxygen may be expressed in terms of equivalent CO_2/CO atmospheres.

The gas mixtures were analyzed with a mass spectrometer. After exposing the specimens for the desired periods of time, 3 min. to 1 hr, they were cooled by pushing them into the cold end of the furnace while maintaining the same atmosphere. In the samples heated for only 3, 5 and 15 min., the phases were not at equilibrium as discussed later.

X-ray and metallographic samples were prepared. The latter were impregnated with bakelite resin (BR-0014) prior to mounting and polishing for metallographic examination.

TABLE 1 – TREATMENT DATA

Specimen No.	Gas Mixture % CO_2	Gas Mixture % CO	Temperature, C	Time, min	Phases Present
1	50	50	1225	3	metal, silica, fayalite
2	50	50	1225	5	metal, silica, fayalite
3	50	50	1225	15	metal, silica, fayalite
4	50	50	1225	60	metal, silica, fayalite
5	50	50	1525	3	metal, silica, fayalite
6	50	50	1525	5	metal, silica, fayalite
7	50	50	1525	15	metal, silica, fayalite
8	50	50	1525	60	metal, silica, fayalite
9	50	50	1565	60	silica, fayalite, magnetite
10	10	90	1225	60	silica, metal
11	10	90	1525	3	metal, silica, fayalite
12	10	90	1525	5	metal, silica, fayalite
13	10	90	1525	15	metal, silica, fayalite
14	10	90	1525	60	metal, silica, fayalite
15	2.7	97.3	1525	60	metal, silica
16	2.7	97.3	1565	60	metal, silica

The various treatments are summarized in Table 1. It should be noted that two of the temperatures, 1225 C (2237 F) and 1525 C (2777 F), are below the melting point of pure iron, 1537 C (2802 F). However, 1525 C (2777 F) is at the melting temperature of oxygen-saturated iron. The experimental locations for the specimens have been superimposed on Darken's equilibrium diagram (Fig. 1).

OBSERVATIONS

Macrostructures

In the presence of reducing atmospheres, those below the curve AB in Fig. 1, only silica sand grain and iron pellets were observed. The latter spheroidized at higher temperatures and remained bright.

With less reducing atmospheres, the metal was first oxidized and then reacted with the silica. Figures 2 and 3 are typical. Low magnification observations show the presence of iron droplets which have developed an oxide coating in a few min. The metal droplets do not wet the sand; however, the oxide melt

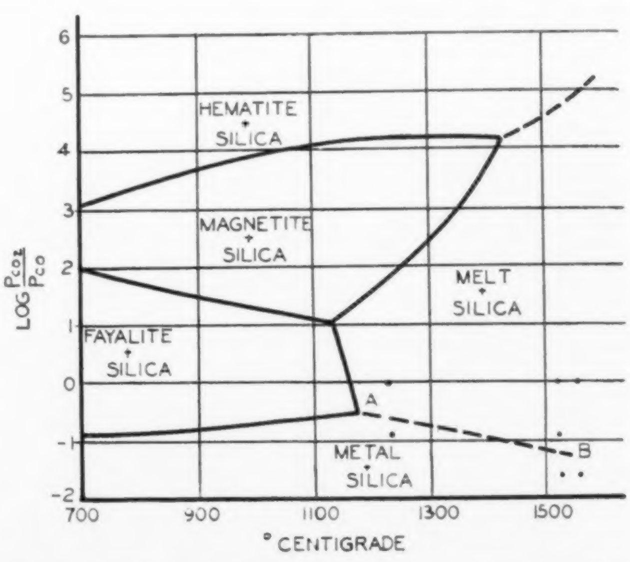

Fig. 1–Experimental locations for specimens superimposed on Darken's[8] equilibrium diagram. Fe-Si-O system SiO_2 side of eutectic.

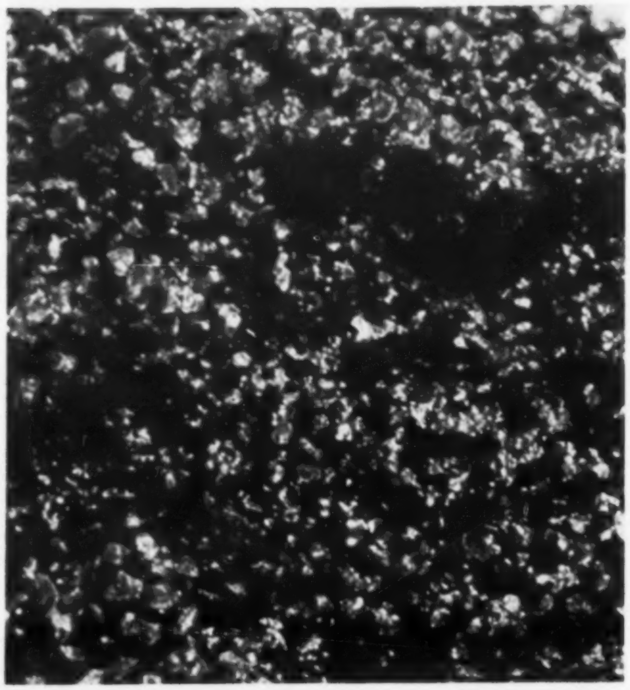

Fig. 2—In less reducing atmosphere, the metal first oxidized and then reacted with the silica. 1525 C for 3 min. 50 per cent CO_2 and 50 per cent CO. 4×.

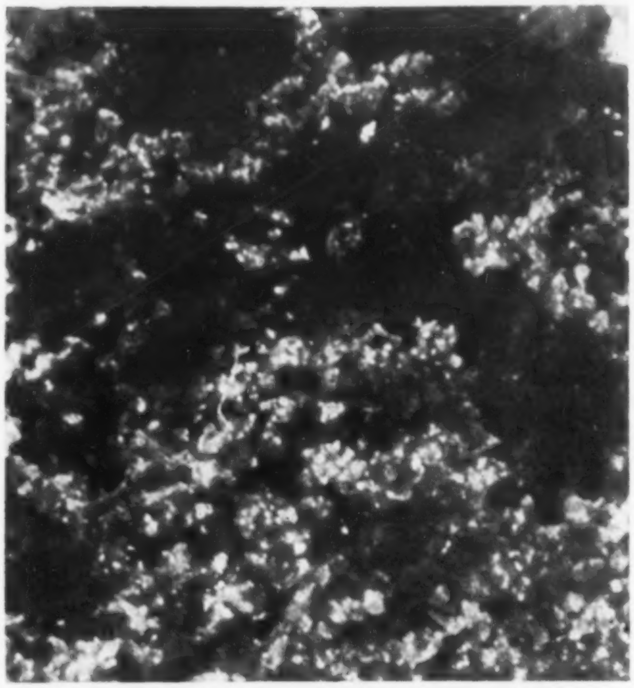

Fig. 3—Decreased reducing atmosphere as in Fig. 2 1525 C for 60 min. 50 per cent CO_2 and 50 per cent CO. 4×.

does. The fluxing of the sand by the oxide enlarges the pore size.

Microstructures

The microstructures developed under reducing atmospheres are summarized in Figs. 4a, 5a, and 6a. In the Fig. 4a, the iron powder is not melted and the silica grains are unaffected. At higher temperatures, the iron was melted and agglomerated as shown in Figs. 5a and 6a. The metal did not wet or react with the silica. Minor changes occurred within the silica grains as a result of their being heated, and not as a result of the accompanying iron.

The microstructures developed under more oxidizing atmospheres are represented by Figs. 4b, 5b, 5c, and 6b. Additional phases were encountered as a result of the presence of iron oxide. These phases are described in Table 2.

Microscopic observations indicate specifically that molten iron does not wet silica. This was true whether an oxide containing phase is present or not (Figs. 5c and 2).

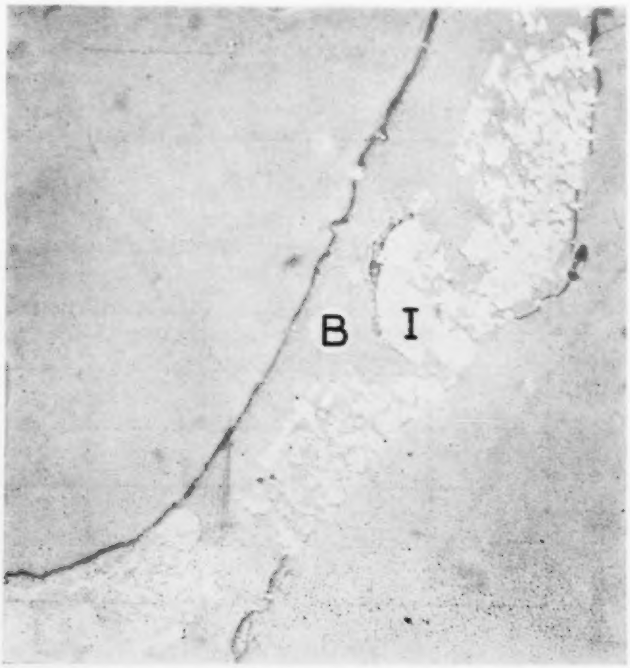

Fig. 4a—Microstructure developed under reducing atmosphere. I—iron, B—bakelite. 1225 C for 60 min. 10 per cent CO_2 and 90 per cent CO. 250×.

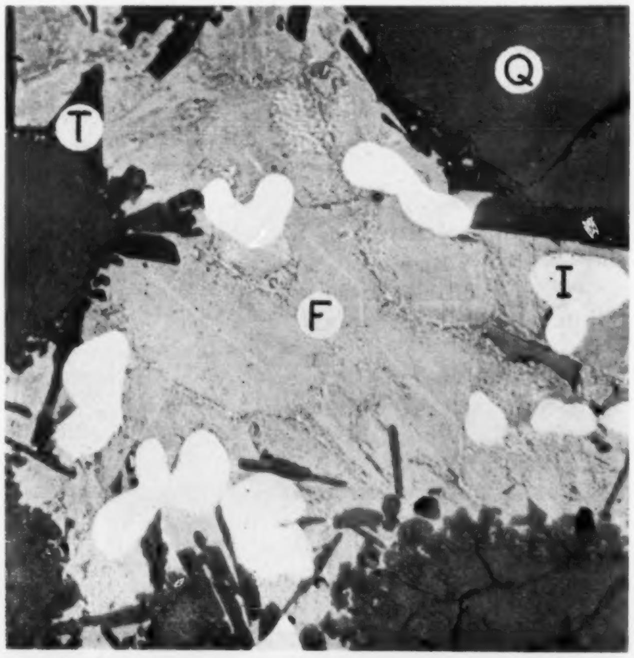

Fig. 4b—Microstructure developed under more oxidizing atmosphere. Q—quartz, I—iron, T—tridymite, F—fayalite. 1225 C for 60 min. 50 per cent CO_2 and 50 per cent CO. 250×.

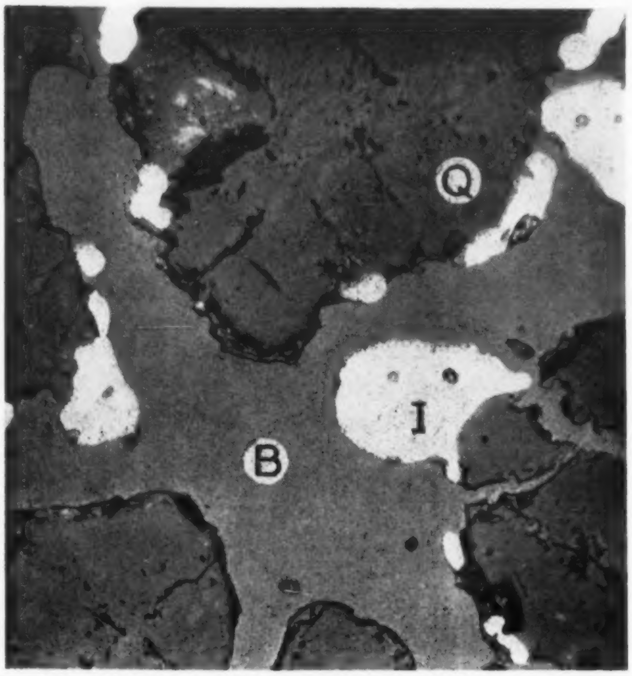

Fig. 5a—Microstructure developed under reducing atmosphere. Q—quartz, I—iron, B—bakelite. 1525 C for 60 min. 2.7 per cent CO_2 and 97.3 per cent CO. 250×.

The molten oxide phase became saturated with silica. This is demonstrated by the fact that silica and silicates are precipitated from the melt that accumulated in the pores of the sand (Figs. 4b, 5b, and 5c). The silica is precipitated as the higher temperature forms, tridymite and cristobalite. These do not revert to the low temperature form of quartz during cooling. The inversion is sluggish because of the high energy requirements for bond disruptions and atom rearrangements.

X-ray Diffraction

The phase identifications made under the microscope were corroborated by x-ray diffraction analyses of three samples.

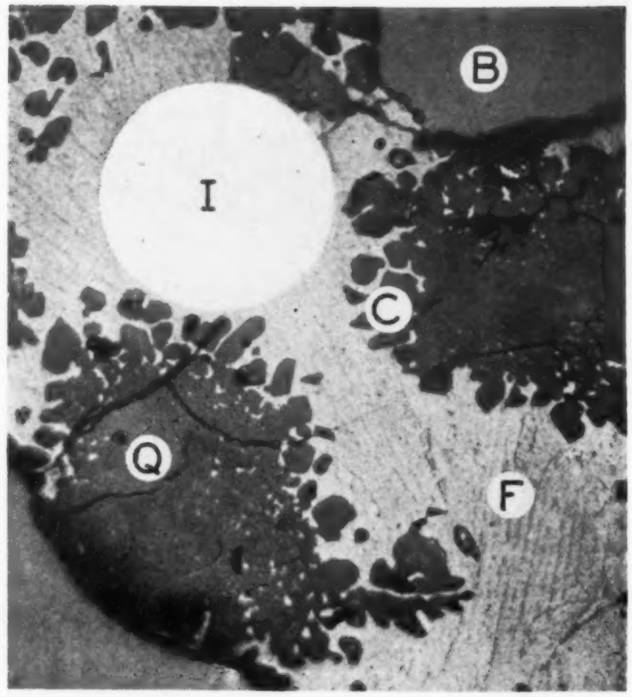

Fig. 5b—Microstructure developed under more oxidizing atmosphere. Q—quartz, I—iron, B—bakelite, C—cristobalite, F—fayalite. 1525 C for 60 min. 10 per cent CO_2 and 90 per cent CO. 250×.

TABLE 2 – ADDITIONAL MICROSTRUCTURE PHASES ENCOUNTERED RESULTING FROM PRESENCE OF IRON OXIDE

Name	Composition	Shape and Color
α Quartz	SiO_2	round grains (gray) stable below 575 C
Tridymite	SiO_2	tabular crystals (dark gray) stable between 1470 C and 870 C
Cristobalite	SiO_2	equi-axed grains (dark gray) stable between 1710 C and 1470 C
Fayalite	Fe_2SiO_4	plate-like crystals (light gray)
Iron	Fe	rounded particles (white)
Magnetite	Fe_3O_4	dendritic crystals (white)
Bakelite	Resin	(medium gray) polishes in reduced relief

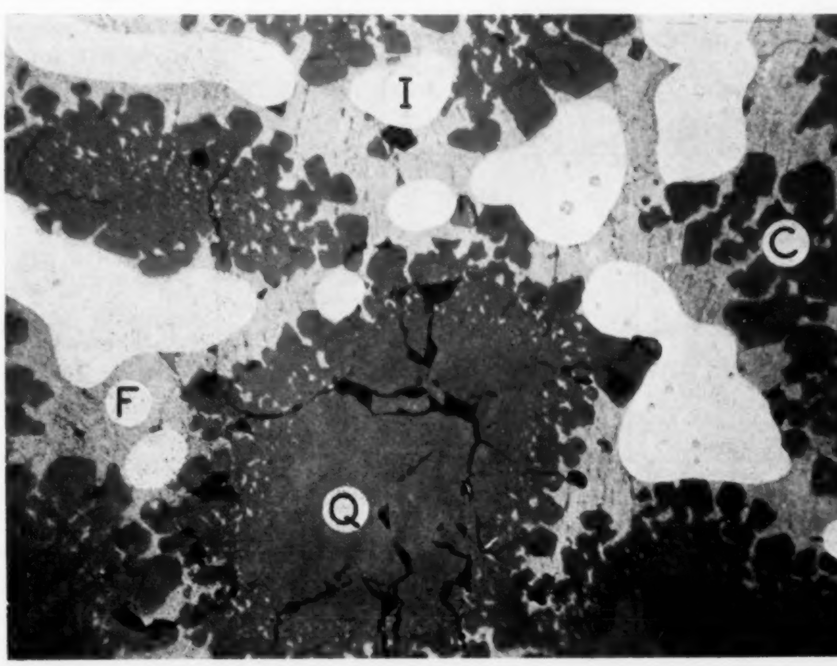

Fig 5c—Microstructure developed under more oxidizing atmospheres. Q—quartz, I—iron, C—cristobalite, F—fayalite. 1525 C for 60 min. 50 per cent CO_2 and 50 per cent CO. 250×.

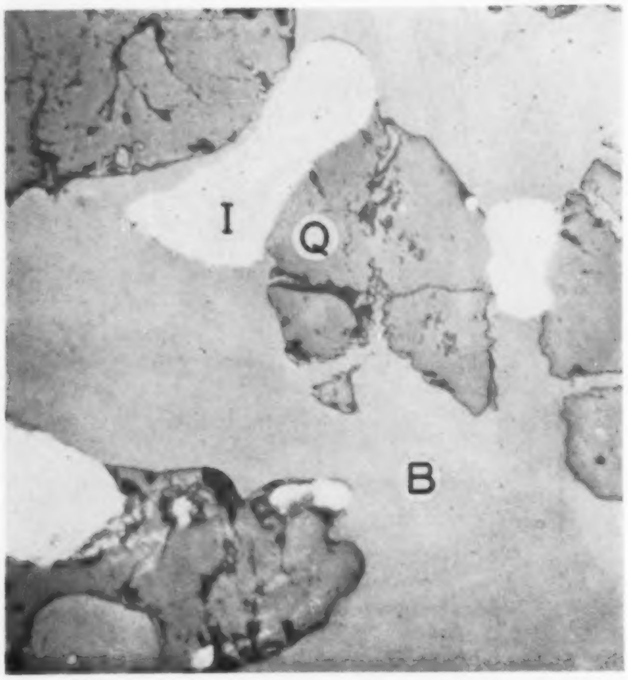

Fig. 6a—Microstructure developed under reducing atmospheres. Q—quartz, I—iron, B—bakelite. 1565 C for 60 min. 2.7 per cent CO_2 and 97.3 per cent CO. 250×.

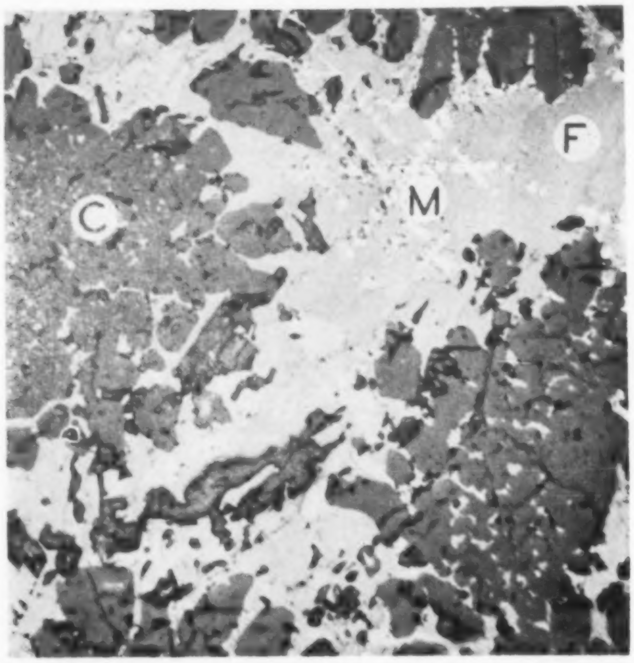

Fig. 6b—Microstructure developed under more oxidizing atmosphere. C—cristobalite, F—fayalite, M—magnetite. 1565 C for 60 min. 50 per cent CO_2 and 50 per cent CO. 250×.

Specimen No.	Major Phases
8	Cristobalite, fayalite, α—quartz, iron.
4	Fayalite, tridymite, α—quartz, iron.
10	α—quartz, iron.

DISCUSSION OF RESULTS

A discussion of the results is handled best in terms of the various temperatures and atmospheres which were chosen for experimentation.

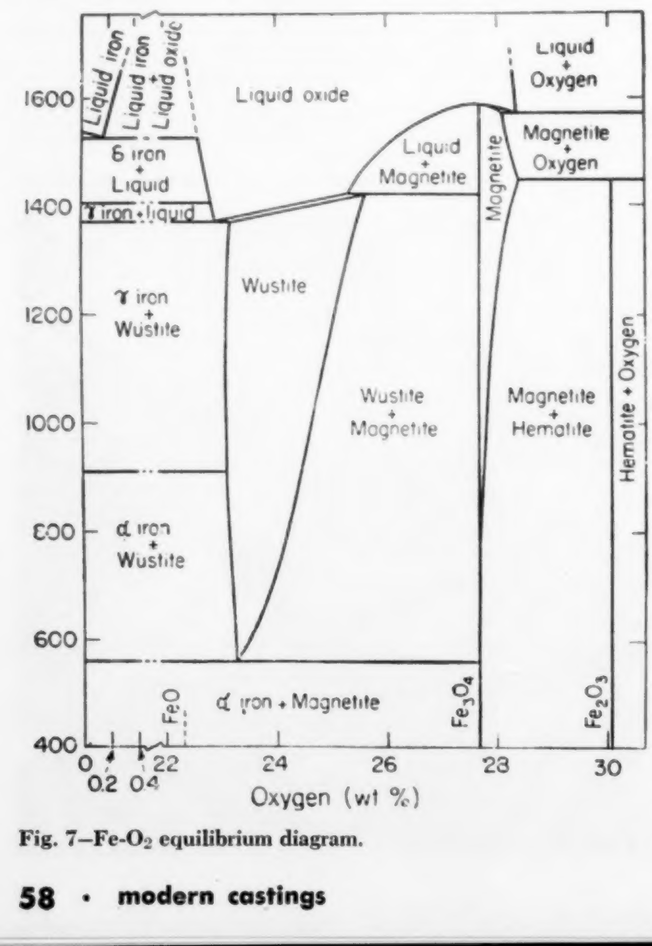

Fig. 7—Fe-O_2 equilibrium diagram.

No oxidation was observed at 1225 C (2237 F) when the atmosphere contained 10 per cent CO_2 and 90 per cent CO. However, when the CO_2/CO ratio was increased from 1:9 to 1:1, (50 per cent CO_2, 50 per cent CO) the iron is oxidized (Fig. 7). The oxide dissolves the silica to form an iron silicate melt (Fig. 10). This melt wets the quartz so that the sand grains are completely surrounded, even into re-entrant angles.

The equilibrium diagram of Darken[8] (Fig. 1), indicates that at 50 per cent CO_2 $\left(\log \frac{P_{CO_2}}{P_{CO}} = 0\right)$ a silicate melt would be in equilibrium with solid silica above 1160 C (2120 F). This means that with sufficient time, the iron would all be converted to melt by reaction with silica.

During cooling, the melt crystallizes to fayalite (Fe_2SiO_4) and precipitates excess silica as tridymite. Tridymite, rather than quartz is encountered since this is the stable form at the crystallization temperature. The transformation of tridymite to quartz is not appreciable during cooling because of the very slow reaction rate.

It should be emphasized that the above specimens never reached the melting point of iron. This indicates that surface reactions can and do occur even though the casting surface may be solid.

The temperature of 1525 C (2777 F) was chosen because it is below the melting temperature of pure iron but at the melting temperature of oxygen saturated iron. At 1525 C, a 10/90 CO_2/CO atmosphere oxidizes the iron. A more reducing atmosphere is required to avoid oxidation. This is predicted from Darken's calculations as shown in Fig. 1 as line AB. This 10/90 CO_2/CO atmosphere did not oxidize the iron at 1225 C (2237 F). As predicted, a 2.7 per

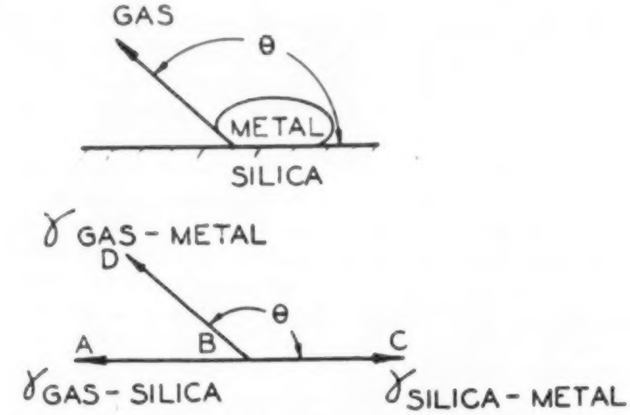

Fig. 8a—Wettability can be derived by considering a drop of metal on a flat silica surface. The angle θ is the contact angle. The droplet shape is the equilibrium result of three forces from the interplay of three surfaces—each trying to minimize its area. This is represented in the equation:

$$\gamma_{\substack{\text{SILICA}\\\text{METAL}}} = \gamma_{\substack{\text{GAS}\\\text{SILICA}}} + \gamma_{\substack{\text{GAS}\\\text{METAL}}} [\cos (180-\theta)]$$

cent CO_2, 97.3 per cent CO atmosphere did not oxidize the iron at 1525 C (2777 F).

Iron was melted in all of the samples at 1565 C (2849 F). In a reducing atmosphere with only 2.7 per cent CO_2, the metallic iron did not react with nor wet the silica grains (Fig. 6a). At a higher CO_2 content, the iron was quickly oxidized (Fig. 6b) and dissolved silica, filling the pore space of the sand compact. During the solidification which followed, the melt crystallized and formed fayalite and cristobalite.

Rate of Reactions

Although no quantitative data are available, an examination of the iron droplets remaining in the platinum envelope as well as the amount of attack of the quartz gives an index of the relative rates of reaction. This is shown in Table 3.

Slag formation depends upon time, temperature, and the oxidizing level at the mold-metal interface. The rate of oxidation and the amount of attack upon the sand increase under more oxidizing environments. It is not generally appreciated that the oxidizing characteristics of a CO_2/CO atmosphere increase with increased temperatures.

Thus increased temperature leads to more pronounced attack for two reasons: 1) At higher temperatures, a more reducing atmosphere is required for protection; 2) when the metal is molten, solution and diffusion of oxygen is more rapid.

TABLE 3 – OBSERVATIONS OF SAMPLES HELD 1 HR AT TEMPERATURE

Temperature	2.7 per cent CO_2	10 per cent CO_2	50 per cent CO_2
1565 C 2849 F	No attack		no iron remaining after 60 min. (only oxidized melt + SiO_2)
1525 C 2777 F	No attack	some iron remains; moderate reaction	some iron remains, rapid attack
1225 C 2237 F		no attack	much iron remains, rapid attack

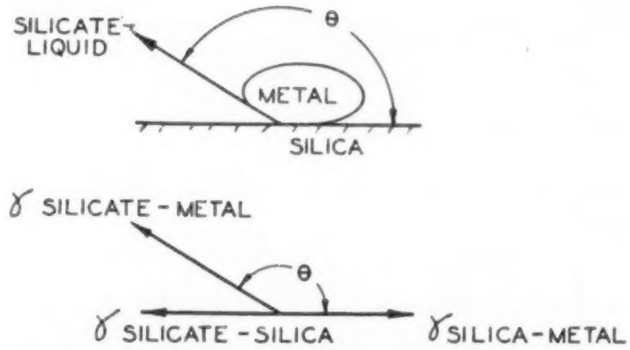

Fig. 8b—The interfacial balance for the situation in Fig. 8a. This is represented by the equation:

$$\gamma_{\substack{\text{SILICA}\\\text{METAL}}} = \gamma_{\substack{\text{SILICATE}\\\text{SILICA}}} + \gamma_{\substack{\text{SILICATE}\\\text{METAL}}} [\cos (180-\theta)]$$

SURFACE ENERGY EFFECTS*

In discussion of the photomicrographs, the subject of interfacial energy was mentioned a number of times. Since the whole question of ease of metal penetration is affected by this problem, it merits special attention.

As a simple illustration, consider two cavities in green sand which are so shallow that the metal pressure is practically zero. Fill one with mercury and the other with water. The mercury will not penetrate the sand-metal interface while the water will rapidly disappear. The water wets the sand. The mercury does not.

A quantitative expression of wettability may be derived as follows: Consider a drop of metal on a flat silica surface as in Fig. 8a. By arbitrary definition,

*In this discussion, surface energy and interfacial energy are used interchangeably. This is correct technically. Frequently, a distinction is made and surface energy is used for cases of a liquid in equilibrium with vapor and interfacial energy for the energy between different solid and liquid phases.

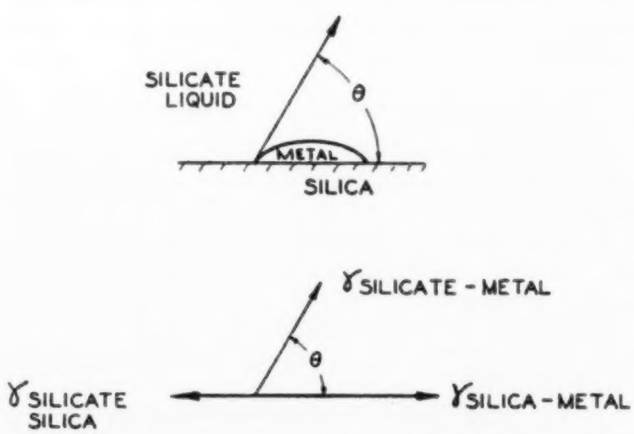

Fig. 9—The necessary appearance of metal wetting silica in the presence of a silicate melt. This is represented by the equations:

$$\gamma_{\substack{\text{SILICATE}\\\text{SILICA}}} = \gamma_{\substack{\text{SILICA}\\\text{METAL}}} + \gamma_{\substack{\text{SILICATE}\\\text{METAL}}} (\cos \theta)$$

$$\gamma_{\substack{\text{SILICA}\\\text{METAL}}} = \gamma_{\substack{\text{SILICATE}\\\text{SILICA}}} - \gamma_{\substack{\text{SILICATE}\\\text{METAL}}} (\cos \theta)$$

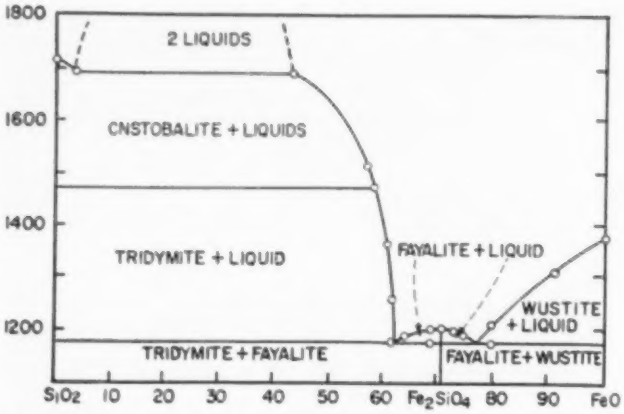

Fig. 10—System FeO-SiO_2 equilibrium diagram.

the angle θ illustrated is called the contact angle. The shape of the droplet is the equilibrium result of three forces from the interplay of three surfaces each attempting to minimize its area, and therefore the surface energy.

These interfaces are: 1) gas-silica BA, 2) metal-gas BD, and 3) silica-metal BC.

Since for equilibrium, the forces must balance, we obtain the horizontal component of the force BD at angle θ in the horizontal plane by multiplying by cos $(180 - \theta)$ and

$$\gamma\,(\text{silica} - \text{metal}) = \gamma\,(\text{gas} - \text{silica}) + \gamma\,(\text{gas} - \text{metal})\,[\cos\,(180 - \theta)]$$

γ is the interfacial tension in dynes/cm, or energy in ergs/cm^2. Physically, the definition ergs/cm^2 may be more satisfying, as representing the energy needed to form a square centimeter of new surface.

Figures 5b and 5c show that when the oxygen content of the metal is increased, the absence of wetting is still evident.

Under these oxidizing conditions, the interfacial balance is shown in Fig. 8b. Even with a silicate melt present, the contact angle θ remains about the same order of magnitude, $>$ 90 degrees.

Figure 9 illustrates the necessary appearance of metal wetting silica in the presence of a silicate melt. It can be seen from specimens 5b and 5c that this condition is not realized.

CONCLUSIONS—APPLICATIONS OF RESULTS

With little metallostatic pressure iron can attack the mold face by chemical action in the following sequence:

1. Iron oxide is formed by reaction with mold gases, the amount depending upon the temperature and partial pressure of oxygen as derived from the pressures of CO_2 and CO and any other gases.
2. The iron oxide wets the silica and penetrates the mold wall.
3. The iron oxide dissolves the silica to form a fluid iron silicate melt (Fig. 10).
4. The dissolving of silica increases the pore size in the mold wall reducing the pressure necessary for metal penetration.
5. The extent of the reaction leading to burnt-on sand and penetration depends upon time, temperature and degree of oxidation of the mold gases.
6. The presence of fayalite in a specimen is evidence of the existence of a prior silicate melt which has crystallized on cooling. More rapid cooling will yield a silicate glass rather than forming fayalite.
7. The depth of metal penetration in sand will be determined by the temperature gradient in the sand. The solidification point of the metal must be determined by referring to the iron-oxygen equilibrium diagram (Fig. 10). The resultant solidification temperature is therefore lower than normally predicted, 1525 C vs 1539 C. This will result in deeper penetration, other factors held constant.
8. If the mold gases are not sufficiently oxidizing for the temperature prevailing no iron silicate melt will be formed as indicated by the equilibrium diagram contained in the text (Fig. 1).

These are important distinctions. Previous investigations have shown that under hydrogen or inert atmospheres, the iron silicate melt is not formed. The data of this report widen the possible range of control, pointing out that below a critical CO_2/CO ratio, which depends upon temperature, no mold attack will take place.

While this investigation did not consider the effect of other elements, some explanations and predictions may be made. It is known that carbon and aluminum lessen the degree of mold attack. Both of these elements preferentially oxidize to form a gas (CO) or a refractory oxide (Al_2O_3) rather than the lower melting iron oxide.

In addition, it is expected that the severe reactions between manganese containing alloys and molds may be explained on a similar basis to that summarized in the conclusions. Manganese oxide fluxes silica more severely than does iron oxide. This hypothesis will be tested in future work.

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REDUCTION OF SILICA IN LARGE SHELL MOLDS

By

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INTRODUCTION

The surfaces of large shell-molded iron castings are more subject to imperfections than are the surfaces of smaller castings. An important potential difficulty arises when large iron castings are made in silica shell molds because some of the silica may be reduced to SiO by certain alloying elements in the molten iron. These surface defects are shown in Fig. 1.

The SiO which is formed is a gas at ferrous casting temperatures. As a result, its formation at the metal-mold interface of the casting provides a porous surface if the gas cannot escape from the mold. As the temperature decreases, the SiO dissociates to SiO_2 according to the reaction:

$$2SiO \ldots\ldots SiO_2 + \underline{Si} \qquad (1)$$

Therefore, the porous metal surface generally contains an SiO_2 deposit.

This paper presents information concerning the nature and extent of the SiO_2 reduction at the mold-metal interface. The roles of temperature, casting size, alloys, and selected mold materials were investigated in order to interpret the mechanism of the reactions. On the basis of the results, methods of minimizing the effects are suggested.

EXPERIMENTAL PROCEDURES

Procedures will be discussed under two headings: 1) Mold Design and, 2) Metal Composition.

Mold Design

Three mold designs were used in this investigation: 1) A small step mold, 2) a small gear-blank mold, and 3) a large step mold. The step mold designs are shown in Fig. 2. With these designs it was hoped to determine the effects of mold volume, section thickness, and parasite section upon the interface reaction. The small step mold has a volume of 19.21 cu in. with an additional 37.95 cu in. in the riser, gates and sprue. The heaviest section is 5-in. x 1-in. x 2-in. thick. The thinnest section is 2-1/2-in. x 1-in. x 1/16-in.

The gear blank mold consisted of three gear blanks with a total volume of 42.25 cu in. The casting was poured through the riser. The heaviest section was a ring 3 in. in diameter, 1-in. wide x 1-in. thick. The large step mold had a volume of 300 cu in. with an additional 225 cu in. in gates, riser, and sprue. The largest section was 8 in. square x 4 in. thick. The total parasite volume was 43 cu in. and the smallest section was 4 in. x 1 in. x 1/8-in.

Shell molds were made over the patterns (Fig. 3) described in the preceding paragraph. The sands used were: 1) two kinds of quartz sands, Geaugea sand, and New Jersey beach sand; 2) forsterite sand; 3) Australian zircon sand; and 4) magnorite. Both the forsterite and the magnorite sands contained an excess of fines as received. The excess fines were removed by elutriation. Size distributions for all sands except the magnorite are reported in Table 1. All molds were made with coated sands. Six per cent of resin by weight was used with all sands except the zircon which had 3 per cent by weight of resin.

Metal Compositions

The metal compositions used were essentially iron-carbon alloys (1-4 per cent carbon) which contained less than 0.05 per cent of silicon and manganese. Other heats were made containing 0.5 per cent silicon and 0.5 per cent manganese to determine what, if any, effect these elements would have upon the reactions.

In the first group of heats, aluminum in the amount of approximately 0.1 per cent was added in the furnace and in the ladle to keep the oxygen level low and to control the carbon boil. In the second group of heats no aluminum or other deoxidizer was used. Rather, the surface of the metal in the furnace and in the ladle was completely covered with a basic slag.

The large castings were poured directly from the furnace into the mold to minimize oxidation and to control casting temperatures more easily. The basic slag was successful in preventing oxidation of the heat. The heats were made in either a 60 lb capacity or a 200 lb capacity induction furnace having rammed magnorite lining. The stock was armco iron, and spectroscopic grade graphite electrode as the source of carbon. Carbon levels ranged from 4 per cent to 1 per cent in steps of 0.5 per cent. Casting temperatures ranged from 3000 F to 2500 F in steps of 100 F.

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RESULTS

The defects shown in Fig. 1 consisted of porosity in the metal at the surface of the casting. The gas pockets contained an accumulation of white powdery material (Figs. 4, 5, 6) which was identified spectroscopically and optically as SiO_2 and Al_2O_3. Optical and electron micrographs revealed that the former had an extremely fine-grained fibrous structure (Figs. 7, 8). It is of prime importance that x-ray and electron diffraction patterns indicated a significant fraction of the fibrous material to be quartz. Furthermore, quartz was the only crystalline silica phase which was observed. The importance of this observation is that quartz is stable, and will form only below 1600 F. Had the SiO_2 crystallized at a higher temperature, the tridymite and cristobalite modifications of silica would have been observed since they do not transform to quartz in the short period of time that is encountered during normal cooling of the casting.

The defects shown in Fig. 1 were the most pronounced under conditions of: 1) greater super-heat, 2) larger metal sections, 3) higher carbon contents, 4) with the presence of aluminum, and 5) in molds with a large amount of free silica. Individual consideration of these variables will show their relative effect.

Effect of Temperature

In a 4 per cent carbon, 0.1 per cent aluminum casting, the defects which have been described were not encountered at temperatures below 2550 F. As the pouring temperatures were increased, the gas pockets and the accompanying SiO_2 deposits were more pronounced (Fig. 9b and c). This same general increase with temperature was noted for all metal compositions (Table 2).

Effect of Section Size

With comparable carbon contents and with silica sand, the defects first appeared in the 19 cu in. castings with 1-in. thick sections at temperatures of about 200-300 F higher than that in the 300 cu in. casting with 4-in. thick sections.

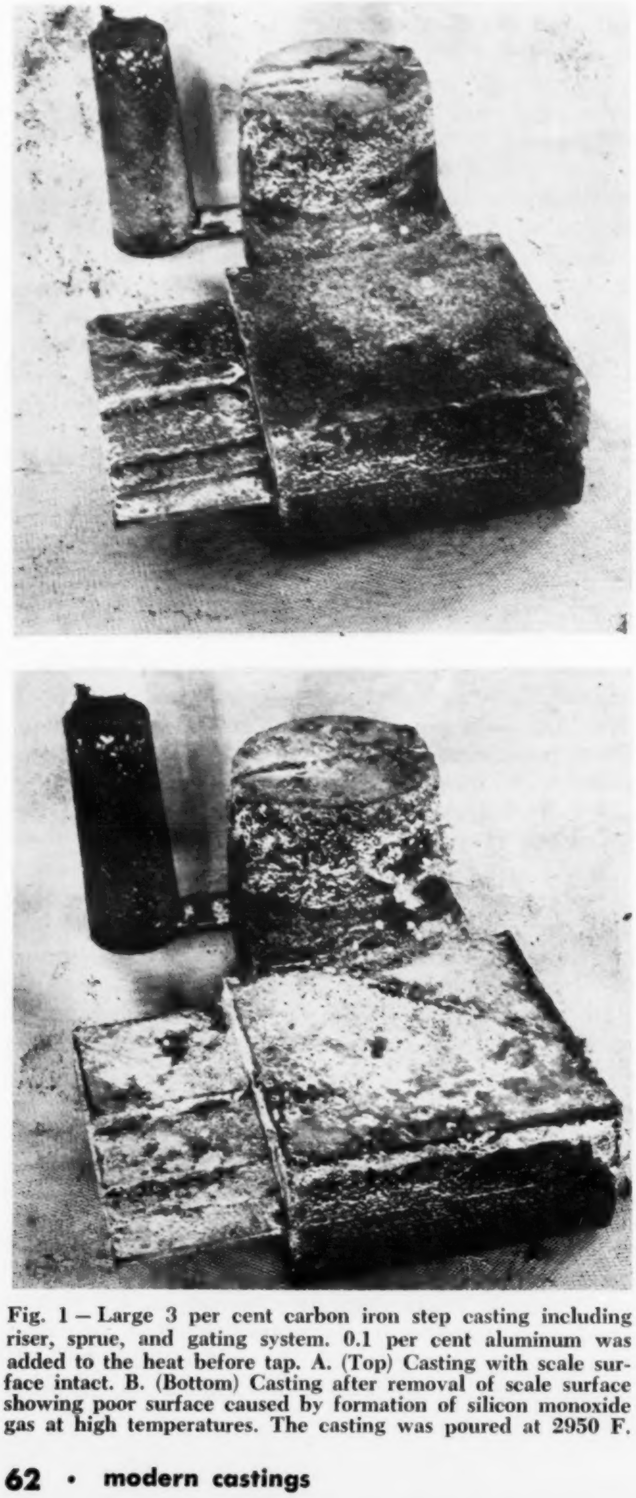


Fig. 1 — Large 3 per cent carbon iron step casting including riser, sprue, and gating system. 0.1 per cent aluminum was added to the heat before tap. A. (Top) Casting with scale surface intact. B. (Bottom) Casting after removal of scale surface showing poor surface caused by formation of silicon monoxide gas at high temperatures. The casting was poured at 2950 F.

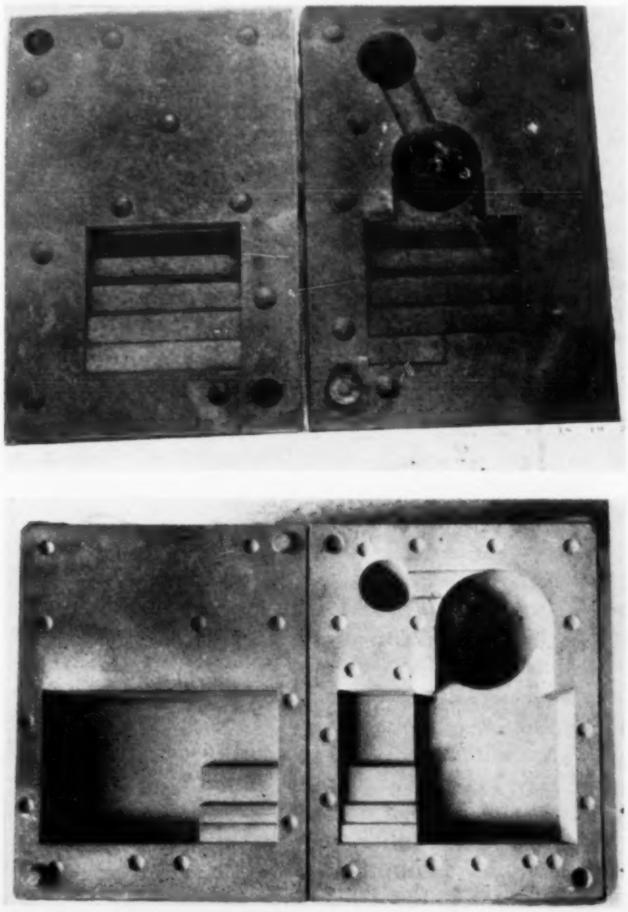


Fig. 2 — A. (Top) Small step mold shell (19 cu. in.). B. (Bottom) Large step mold shell (300 cu in.) showing cope and drag sections.

TABLE 1 – SIZE DISTRIBUTION OF FOUNDRY SANDS USED

Sieve Size	Geaugea Lake Sand Weight %	Geaugea Lake Sand Cumulative %	New Jersey Beach Sand Weight %	New Jersey Beach Sand Cumulative %	Forsterite Sand Weight %	Forsterite Sand Cumulative %	Australian Zircon Sand Weight %	Australian Zircon Sand Cumulative %
+20 mesh	0.04	0.04	0.01	0.01	0.01	0.01	0.00	0.00
−20 +48	3.73	3.77	0.74	0.75	3.73	3.74	0.01	0.01
−48 +70	24.19	27.96	21.44	22.19	30.01	33.75	2.35	2.36
−70 +100	41.09	69.05	55.13	77.32	40.38	71.13	44.32	46.68
−100 +140	19.84	88.89	18.97	96.24	22.48	96.61	48.38	95.06
−140 +200	7.21	96.10	3.07	99.36	2.89	99.50	4.77	99.83
−200 +270	2.38	98.48	0.50	99.86	0.35	99.85	0.15	99.98
−270	1.52	100.00	0.14	100.00	0.15	100.00	0.02	100.00

Geaugea sand 85.12% in range −48 mesh +140 mesh. (6% resin by weight)
New Jersey sand 95.54% in range −48 mesh +140 mesh. (6% resin by weight)
Forsterite sand 92.87% in range −48 mesh +140 mesh. (6% resin by weight)
Australian Zircon sand 92.70% in range −70 mesh +140 mesh. (3% resin by weight)

Effect of Carbon Content

Other factors being equal, these defects were more pronounced with higher carbon contents. For example, a 1 per cent carbon, 0.1 per cent aluminum casting does not produce surface porosity even at 3000 F, whereas the defect occurs at a temperature as low as 2550 F when 4 per cent carbon is present (Table 2).

Effect of Alloy Additions

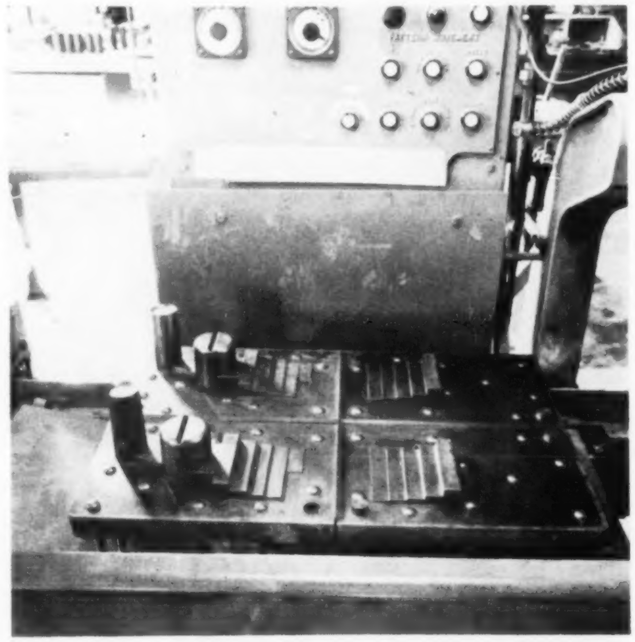
Aluminum additions to the molten metal have a more pronounced effect upon the defect than carbon. With 0.1 per cent aluminum, the lowest temperature at which the defect was encountered in a 4 per cent carbon melt was 2550 F. With nil aluminum, the defect was not encountered at 3000 F.

Silicon and manganese additions up to 0.5 per cent did not have any noticeable effect upon the presence or absence of the gas porosity and the SiO_2 deposits at the surface of the castings.

TABLE 2 – SELECTED HEATS SHOWING EFFECTS OF CARBON, ALUMINUM, CASTING TEMPERATURE MOLD COMPOSITION AND MOLD SIZE UPON DEFECT FORMATION

% Carbon	% Aluminum	Casting Temp. F	Mold Sand	Mold Size*	Defect
1.0	0	3000	Silica	C	Absent
1.0	0.1	3000	Silica	A	Absent
1.5	0	2800	Silica	B	Absent
1.5	0	2820	Forsterite	B	Absent
1.5	0.1	3140	Silica	A	Absent
1.5	0.1	3160	Forsterite	A	Absent
2.0	0	2950	Silica	C	Absent
2.0	0.1	2950	Silica	C	Present
2.5	0.1	2810	Zircon	C	Present
3.0	0	2950	Silica	C	Absent
3.0[1]	0.1	3100	Silica	C	Present
3.0	0.1	2700	Silica	C	Present
3.0	0.1	2960	Forsterite	C	Present
3.0	0.1	3100	Zircon	C	Present
4.0	0	2980	Silica	C	Absent
4.0[2]	(SMZ)	3030	Silica	C	Absent
4.0[3]	0.1	3000	Silica	C	Present
4.0	0.1	2920	Silica	A	Present
4.0	0.1	2380	Silica	A	Absent
4.0[4]	0.1	2980	Zircon	A	Absent
4.0	0.1	3000	Magnorite	C	Present

*A–Small step mold (Fig. 2a)
B–Small gear blank mold (Fig. 9)
C–Large step mold (Fig. 2b)
1–See Fig. 1.
2–No aluminum was added to heat but 0.1 per cent SMZ alloy (silicon, manganese, zirconium) was added in furnace just before pouring.
3–See Fig. 4, 5, and 6.
4–See Fig. 9.



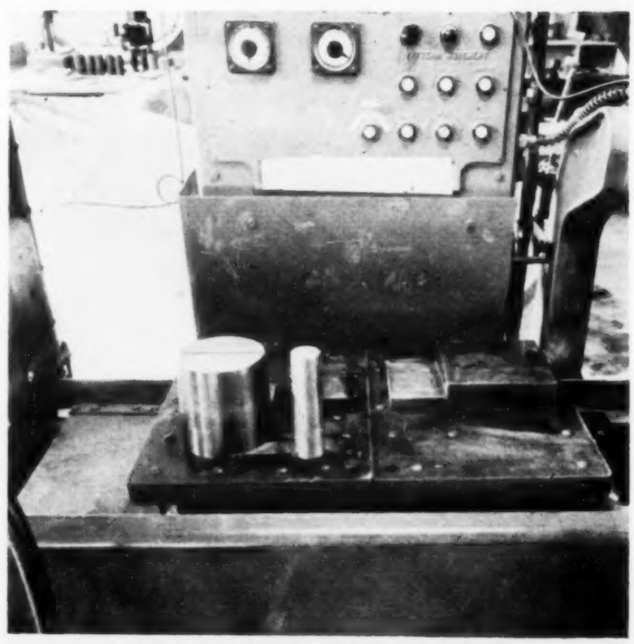


Fig. 3 – A. (Top) Small step mold patterns. B. (Bottom) Large step mold pattern on ejection platform of shell mold machine.

Effect of Mold Compositions

The described defect is most pronounced in a silica sand shell mold. In shell molds of forsterite (Mg_2SiO_4), zircon ($ZrSiO_4$) (Fig. 9a), or periclase (MgO-containing 10 per cent SiO_2), defects were produced only when other factors were adverse; with high casting temperatures, large section sizes, high carbon, and the presence of aluminum.

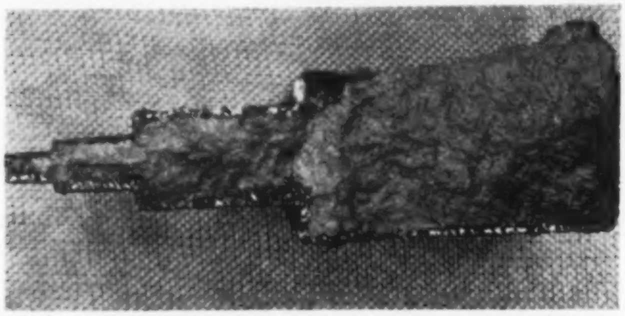


Fig. 4 – Fractured cross section of 4 per cent carbon iron step casting, with white fibrous silica filling gas pockets extending beneath casting surface. Reduced 1/2 in reproduction.

Fig. 5 – White fibrous silica filling gas pockets extending beneath surface of 4 per cent carbon iron casting. 5X.

Fig. 6 – Cross-section of part of a casting showing white fibrous silica filling gas hole which completely penetrates 1/4-in. section. 8X.

The effect of mold composition is especially notable in the smaller castings. When a 4 per cent carbon iron containing 0.1 per cent of aluminum was cast at 2900 F into the small gear blank mold made of zircon sand, little porosity was produced (Fig. 9a). When iron of the same composition was cast at the same temperature into the large step mold made of zircon sand, a condition similar to that shown in Fig. 1 was observed. With silica sand the defect was found in both large and small castings.

DISCUSSION

The surface defects must originate from reactions involving silicon and oxygen. This is supported by the facts that 1) silica shells provided the most severe effects, and 2) an SiO_2 desposit is produced. At least three hypotheses may be advanced to account for reactions between the silicon and oxygen.

The first possible mechanism would involve the oxidation of silicon in the metal to produce SiO_2 in the gas pockets. Silicon oxidation is observed in higher silicon steels. However, gas porosity does not result. The resulting SiO_2 forms a liquid at temperatures above 1600 F. Furthermore, a silicon addition to the metal in this case had no noticeable effect upon the presence or absence of the defects. This possible mechanism must be discarded for these castings.

A second possible reaction mechanism would involve the reduction of SiO_2 in the sand by heated resins in the shell to produce an initial gas containing SiO. Although well known in chemistry, SiO is relatively unknown in metallurgy. Therefore, a selected list of references concerning the reduction of SiO_2 and SiO formation is given in Appendix 2.

$$xSiO_2 + C_xH_{2y} \ldots\ldots\ldots\ldots SiO + xCO + yH_2 \qquad (2)$$

Fig. 7 – Photomicrograph in transmitted polarized light of white fibrous silica from high carbon iron step casting surface. 125X.

This reaction would require a pressure accumulation at the surface of the metal during solidification. There are several evidences to suggest that the contact of the molten metal softens the bonding resin behind the mold surface to clog the pores in the sand. This produces an impermeable sand which will permit such pressure to build up. Under this mechanism, the SiO would revert at lower temperatures to SiO_2. Thermodynamic considerations favor this reversal.

The plausibility of this second suggested mechanism is greater than for the first. Higher temperatures would increase the reaction by producing more SiO and more gas pressure. Likewise, larger castings would accentuate the results by providing longer cooling times. However, it is difficult to account for the significant effect of carbon and aluminum upon the presence of the defects.

The third possible reaction also involves the reduction of the SiO_2 in the sand, but by the carbon and aluminum in the metal.

$$\underline{C} + SiO_2 \;\ldots\ldots\ldots\ldots\; CO + SiO \qquad (3)$$

$$2\overline{Al} + 3SiO_2 \;\ldots\ldots\ldots\ldots\; Al_2O_3 + SiO \qquad (4)$$

Aside from the fact that the reducing agents come from the metal rather than from the resins, this mechanism is similar to the previously suggested one. Both of the reactions occur more strongly at higher temperatures. Both produce SiO and require a retention of the gas by pressure at the mold-metal surface until dissociation occurs at lower temperatures to produce SiO_2.*

$$2SiO \;\ldots\ldots\ldots\ldots\; SiO_2 + \underline{Si} \qquad (1)$$

Most probably the true mechanism requires both the reducing action of alloys within the metal and the protective reducing gases of the heated resins. Otherwise, the SiO would diffuse into the mold where it would oxidize with infiltrating air.

The avoidance of these defects may be suggested directly from the results of the tests. This would involve a minimum of super-heat, and avoidance of aluminum (and probably titanium and zirconium) in the metal, and in large castings the use of sands without free silica.

*Equation (1) is exothermic; therefore, it occurs more strongly to the right at lower temperatures.

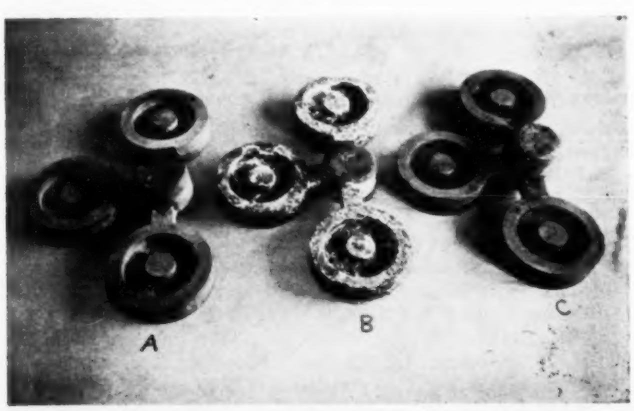


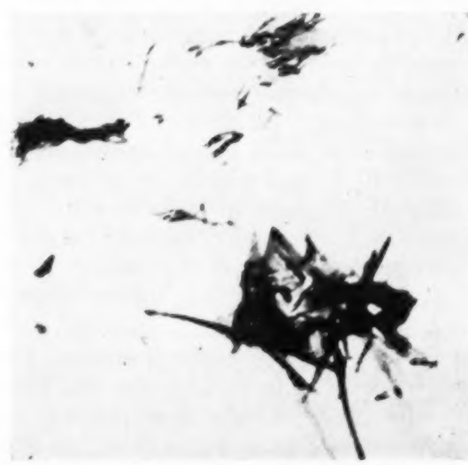
Fig. 9 – Four per cent carbon iron cast into shell molds. A. Cast into zircon sand mold at 2900 F (about 700 degrees of superheat). B. Cast into quartz sand shell mold at 2900 F. C. Cast into quartz sand shell mold at 2500 F (about 300 degrees of superheat).

SUMMARY AND CONCLUSIONS

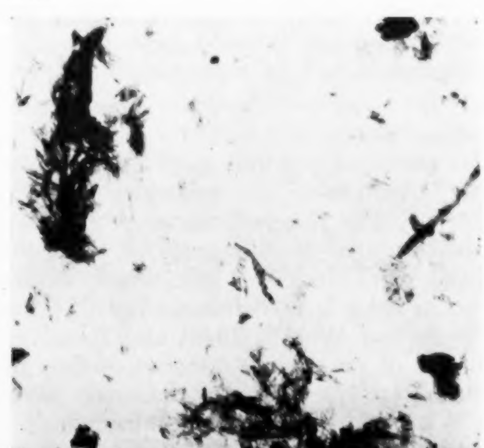
Although the reduction of SiO_2 to a gaseous SiO form by carbon and other elements has been known for some time, its importance in the control surface quality of ferrous castings has not been generally appreciated. When conditions involving high carbon contents, the presence of aluminum or other strong oxide formers, high temperatures, or large mold sizes are encountered, SiO_2 will be reduced to SiO when

Fig. 8–Electron micrographs of white fibrous silica from surfaces of high carbon iron step castings. 30,000×.

A. From casting made in quartz shell.



B. From casting made in forsterite (Mg_2SiO_4) shell.



C. From casting made in zircon ($ZrSiO_4$) shell.

iron is cast into molds containing quartz or silicate sands. The SiO, even though it is in the form of a gas, does not always escape from the mold cavity and may produce a surface porosity. Lower temperatures permit the dissociation of SiO to SiO_2.

ACKNOWLEDGMENT

This study was initiated as a result of problems encountered in certain castings made in connection with Army Ordnance Project DA 20-018-ORD-13832.

APPENDIX 1 – FORMATION OF SILICON MONOXIDE AND REDUCTION OF SILICA

The reduction of silica to a volatile suboxide has been known for some time and was postulated even before it had been found. Before 1900, C. Winkler[1] stated that an oxide lower than SiO_2 should exist, but he was unsuccessful in his attempts to produce it. About 1900, H. N. Potter[2-7] noted a white condensate around an electric arc furnace, and upon analysis found it to correspond to SiO. He patented the process and sold the product under the trade name of *monox* for use as a pigment, polishing agent, or lubricant. However, his only proof of its composition was his chemical analysis, and he could not disprove the objection that it might be a mixture of Si and SiO_2.

Dufour[8] in France in 1904 formed a fibrous silica which had the SiO composition and which he called *silice capillaire*. He found that this was formed when silica was reduced with hydrogen. A number of other investigators between 1900 and 1920[9-15] mentioned the monoxide of silicon. One is of especial interest. H. von Wartenberg[15] (1912) found silica to be reduced by carbon at 2280 F and above, and by CO and H_2 at 2640 F and above, to a more reduced volatile state. He thought this volatile state was probably silicon which was carried away in the gas stream. Von Wartenberg also found that silicates could be reduced similarly at somewhat higher temperatures.

Between 1920 and 1940 silicon monoxide was mentioned a number of times in the literature. The most important work of this period was by Jevons[19, 20] (1924-28) who presented the first positive evidence of the existence of SiO as a gas from his ultraviolet band spectra studies. Bonhoeffer[21] identified SiO spectroscopically as the product of reaction between C and SiO_2 at temperatures above 1500 C. Biltz and Ehrlich[24] (1938) also showed positive evidence of the existence of SiO in their volatility studies.

Since 1940 more work has been done on the formation and properties of SiO.[25-44] Zapffe and Sims[29-31] (1940-44) reviewed previous work and discussed further the formation of the suboxides of silicon and other metals. The thermodynamic properties of SiO were also reported in this period.[33-37] In industrial processes, Van Vlack[34] (1948) found evidence of reduction of silica in blast furnace hearth refractories, and Wright and Wolff[35] (1948) also found evidence of reduction of siliceous refractories used in pyrolysis of natural gas. They did not, however, discuss the formation of SiO. No mention has been made of this phenomenon in reports on foundry operations as far as we have been able to determine.

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DIE AND PERMANENT MOLD CASTING OF NON-FERROUS METALS IN THE UNITED KINGDOM

By

L. J. Brice* and G. A. Broughton**

INTRODUCTION

With the comparatively restricted resources and markets available to the United Kingdom, its achievements in the die and permanent mold casting fields may perhaps seem insignificant compared with those in the United States. On the other hand, such casting in metal molds is an important factor in the economic life of the country, and many industries rely on die and permanent mold castings for production of large numbers of components at a highly competitive price. There has been steady progress with many improvements in techniques, and recently there have been certain successful developments and activities which have given no little impetus to the industry.

Also, there has been a considerable change of attitude among engineers towards die and permanent mold castings, and many components have been changed over to this process, usually with at least partial re-designing to suit the die casting technique. Moreover, there is a growing tendency for engineers to discuss new projects with manufacturers at the drawing-board stage.

PRODUCTION FOR INDUSTRY

Co-operative Activities

Trade Associations. As in the United States, firms engaged in die and permanent mold casting can be grouped as either captives or jobbers. While many of these are independent, a number are members of one or other of the relevant trade associations.

Light Metal Founders Association. This was formed towards the end of 1939 as a direct link between the Government and industry, to ensure the maximum and most efficient war effort. The liaison activities have continued and the Technical Committee has been successful in finalizing agreements on methods, practices, testing, inspection and standards to the benefit of those engaged in the founding of light alloys.

Association of Bronze and Brass Founders. This was formed in 1942 also as a representative body for negotiating with the Government. The Technical Committee has issued a "Code of Inspection Procedure" to facilitate uniform inspection requirements and procedures throughout the various Government departments. The Association collaborates actively with the British Standards Institution, urging wherever possible the adoption of higher values of mechanical properties for many of the common casting alloys.

It is compiling a booklet for engineering designers, and others, giving information on composition, properties and applications of copper casting alloys, with lists of corresponding American, Continental and British Government specifications.

Zinc Alloy Die Casters Association. This was formed in 1942 to provide users with information on properties, design and applications of zinc alloy die castings, to promote the inter-change of technical information and generally to promote the proper uses of die casting. There have been several useful technical publications and films, and specimen die castings are provided for exhibitions and lectures.

Magnesium die and permanent mold casters are linked through the Magnesium Industry Council and its Technical Committee.

British Non-Ferrous Metals Research Association. Organized under the aegis of the Department of Scientific and Industrial Research, this association now has more than 600 members, a staff of over 170 and extensive laboratories. Its work, as well as that of the A.B.B.F., was referred to in the paper by French and Mantle presented to the AFS annual meeting last year. It is supported by contributions from individual firms, trade associations and the Government. Its members receive results of research projects and the benefits of an efficient advisory service, library and information services and a development department.

War-time Co-operation. A tribute must be paid to the way in which the industry co-operated to the fullest extent to meet the insatiable needs of the armed forces and especially to the way in which firms generously shared their knowledge and experience with firms in production difficulties, who would normally be their competitors.

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**Ministry of Supply, A. 6., London.

European Pressure Die Casting Committee. This committee, formed in 1953 largely through the initiative of the Z.A.D.C.A., consists of national associations of die casters and individual firms in countries without associations. To date, Austria, Belgium, Denmark, France, Germany, Holland, Italy, Spain, Sweden, Switzerland, and the United Kingdom are represented.

The principle aim is to further the use of die casting in Europe through:

1. Reports at meetings on new applications, new publications and consumption statistics.
2. General publicity, including the issue of bulletins illustrating applications, the holding of exhibitions and correspondence between members on activities in various countries.
3. Consideration of research projects on the finishing and application of die castings.
4. Exchange of information on the education of engineering students in die casting.
5. Visits to members' works in the neighborhood of a meeting place.

A sub-committee has drawn up a draft European standard for zinc alloy ingots and die castings based on existing national standards. The American Die Casting Institute's Product Standards have been translated into French, German, and Italian and distributed to members, who have also worked together in publishing a "Glossary of Die Casting Terms", in English, French, German, Italian and Spanish.

Two European conferences have been held, the first in London in 1954 and the second in Paris in 1957, at which there were also good contingents from the United States and the Union of Soviet Socialist Republics.

Missions to the United States. The productivity missions to the United States have been of considerable interest and benefit to the industry through the issue of the detailed reports and the discussions that have taken place. Many modifications to British practice have resulted from these visits, although it is difficult to report on these specifically. Possibly the major lesson learned from the visits was in regard to the mechanical handling of both metal and castings. While full advantage of the lessons learned could not always be taken, usually on account of the variety and comparatively small output of castings involved, many improvements have been made in this direction. Information gained from these visits is of particular value when new plant layouts are being prepared and machines re-housed.

Alloys

The standard alloys in current use for die and permanent mold casting, accounting for the bulk of United Kingdom production, are indicated in Tables 1-4.

Aluminum Alloys. There is a reasonable choice for permanent mold casting. Alloys in general favor are LM.4, 6, 8; 10 and 22 for stressed applications; and 12 to 14 for elevated temperatures (pistons). For die casting, the most popular alloys are LM.24 (with relatively high iron limit to reduce sticking and give increased quality and die life), LM.2 and LM.6 (best for corrosion resistance), in that order. LM.5 is used particularly where corrosion resistance is of vital importance (marine applications), when the magnesium content of the alloy is maintained as near as possible to 5 per cent. A modified alloy containing up to 7.5 per cent magnesium and up to 1.8 per cent iron is finding favor.

Production of castings in 1956 amounted to 78,000 tons, comprising 27 per cent sand castings, 53 per cent permanent mold castings and 20 per cent die castings. Over the last 10 years, the annual production of die castings has progressively increased from about 6 per cent while that of sand castings has decreased from about 40 per cent.

Magnesium Alloys. Production in 1956 amounted to nearly 3,500 tons, comprising 90 per cent sand castings, 6 per cent permanent mold castings, and 4 per cent die castings.

Zinc Alloys. There is little use of B.S. 1004B, the copper bearing alloy, which however continues to be favored for zip fasteners. The bulk of production is in B.S. 1004A. The impurity limits are still lower than those in United States specifications. Indium and thallium limits were introduced in 1955 in view of their alleged serious embrittling effects. The production in 1956 was of the order of 40,000 tons.

Recently, interest has been aroused in a new alloy containing approximately 65 per cent zinc, 30 per cent aluminum, and 5 per cent copper, for which the mechanical properties in Table 1 are claimed.

TABLE 1 – MECHANICAL PROPERTIES ALLOY, CONTAINING 65 PER CENT ZINC, 30 PER CENT ALUMINUM AND 5 PER CENT COPPER

	Die Cast	Permanent Mold Cast
Tensile strength t./sq. in.	(a) 26, (b) 22	(a) 26
Elongation, %	1	2
Brinell hardness	(a) 110, (b) 70-93 (c) 87-100	(a) 110
Impact strength ft. lb—unnotched	(a) 3.5, (b) 4.0 (c) 3.7	(a) 3.5
Impact strength −40 C and F ft. lb—unnotched	3.2	—
Growth after dry aging (as cast)	0.0031-in. per in.	—
Growth after dry aging (stabilized) (d)	0.0002-in. per in.	—

(a)—as cast (b)—dry aged (c)—steam aged
(d)—12 hr at 220-230 C (428-446 F), air cooled

TABLE 2 – EUROPEAN DIE CASTING COMPARATIVE PRODUCTION FIGURES

Alloy	France	Germany	Italy	U.K.
	(000's Metric Tons)			
Zinc	17	15	5.5	40
Aluminum	N/A	15	15	18

TABLE 3 – TYPICAL COMPOSITION OF STEELS USED FOR ALUMINUM AND MAGNESIUM ALLOYS

	%C	%Si	%Mn	%W	%Cr	%Mo	%V
Aluminum	0.45	1.0	0.4	. .	5.0	1.3	1.5
Magnesium	0.3	0.9	0.3	1.0	4.8	1.6	. .
	0.4	1.05	. .	. .	5.0	1.35	1.1
Zinc	0.3-0.34	0.2-0.25	0.45-0.55	0.15-0.25	0.95-1.05	0.7-0.8	. .

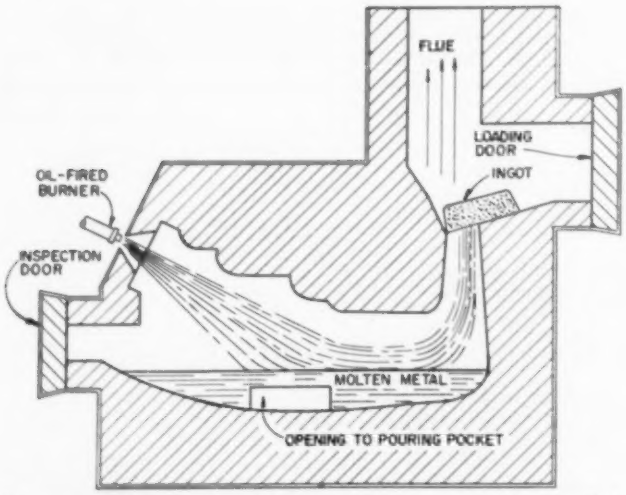

Fig. 1 – Holding and melting reverberatory furnace installed for aluminum bronze production.

The alloy is reported to be reasonably resistant to corrosion in distilled water, tap water, and salt spray.

Permanent mold castings have been made to replace aluminum-bronze pulley wheels and to replace case-hardened steel bearing sleeves. Die castings have been produced for small worm wheels, and as a replacement of zinc or aluminum alloys for small housings which originally incorporated bronze bushes cast in as inserts, the complete castings now being made in the new alloy.

Copper Alloys. The compositions quoted in Table 1 are those covering permanent mold castings. Die castings are made in ordinary brass, manganese brass, and silicon brass, but the production is limited and there is no specification for a copper-base die-casting alloy. Experiments have been made in die casting aluminum-bronze, but there is no current production as there does not appear to be sufficient advantages over sand castings.

The current production figures are probably of the order of 14,000 tons of permanent mold castings and 800 tons only of die castings.

European Die Casting. The current comparative production figures given in Table 2 may be of interest.

Melting Equipment

The usual types of gas or oil crucible-melting and holding furnaces with tilting or ladling facilities are in operation. Now that electricity supplies are adequate and comparatively free from break-down, there is increasing interest in electric heating.

One company, specializing in the production of aluminum-bronze castings has recently installed a combined holding and melting furnace of the reverberatory type (Fig. 1). The pre-alloyed ingots are loaded on to a charging hearth at the back of the furnace and melted by the exhaust flame. The metal drops into the body of the furnace, which has a ladling pocket on each side into which molten metal flows, passing under a weir brick which holds back slag and oxide and prevents flames from blowing out on to the operator.

Fuel costs have been reduced by 30 per cent, and melting losses have been within 1-2 per cent of the losses experienced with crucible melting. Also, the time previously lost while crucible furnaces were being replenished from tilting furnaces has been saved.

Low-frequency induction-melting units are coming into use for both die and permanent mold casting

TABLE 4 – STANDARD ALUMINUM ALLOYS FOR DIE AND PERMANENT MOLD CASTINGS

B.S. 1490	Main Alloying Elements, %							Tensile Strength t/sq. in (min)		Elongation			
	CU	Mg	Si	Fe	Mn	Ni	Zn	Sand Cast	Chill Cast	Sand Cast	Chill Cast	Casting Process	Related A.S.T.M. Spec. B179-51T
LM1-M	7	..	3	..	..	..	3	8.0	10.0	..	..	PM	CS 72A
LM2-M	1.5	..	10	..	..	..	..	8.0	9.5	..	..	D	..
LM4-M	3	..	5	..	0.5	..	..	9.0	10.0	2	2	D.PM	SC 54
LM5-M	..	4.5	..	..	0.5	..	..	9.0	11.0	3	5	PM	G 4A
LM6-M	..	..	11.5	..	..	..	..	10.5	12.0	5	7	D.PM	S12A
LM7-M	1.75	0.1	2.5	0.75	..	1.0	Ti+Nb0.2	9.0	10.0	2	2	PM	..
LM8-M	..	0.5	5.25	..	0.5	..	..	8.0	10.5	2	3	PM	SG 70A
-P								9.5	12.0	1	2		
-W								10.5	15.0	2.5	5		
-WP								15.0	18.0	..	2		
LM9-P	..	0.5	11.5	..	0.5	..	..	11.0	15.0	1.5	2	PM	..
-WP								15.5	19.0	..	..		
LM10-W	..	10.25	..	..	..	..	..	18.0	20.0	8	12	PM	G 10A
LM11-W	4.5	..	..	..	..	..	Ti+Nb.02	14.0	17.0	7	13	PM	..
-WP								18.0	20.0	4	9		
LM12-WP	9.75	0.25	..	1.0	..	..	..	..	..	..	..	PM (Pistons)	CG 100A
LM13-WP	1.0	1.0	11.75	..	..	2.5	..	11.0	16.0	..	..	PM (Pistons)	SN 122A
-WP (spl)								9.0	13.0	..	..		
LM14-WP	4.0	1.5	..	..	..	2.0	..	14.0	18.0	..	..	PM	
-WP (spl)								12.0	15.0	..	..	PM (Pistons)	CN 42A
LM15-WP	2.0	1.0	1.25	1.0	..	1.25	Ti+Nb.02	18.0	21.0	..	..	PM	..
LM16-W	1.25	0.5	5.0	..	..	..	..	11.0	13.0	2	3	PM	SC51A
-WP								15.0	17.0	..	..		
LM18-M	..	..	5.25	..	..	..	..	7.5	9.0	3	4	PM	S 5A
LM20-M	..	..	11.75	..	..	..	..	10.5	12.0	3.5	5	D.PM	S 12A
LM21-M	3.0	..	5.0	..	0.5	..	..	9.0	10.0	1.5	1.5	PM	SC 54A
LM22-W	3.25	..	5.0	..	0.5	..	..	..	16.0	..	8.0	PM	..
LM23-P	1.5	0.1	2.0	1.0	..	1.25	Ti+Nb.02	10.0	12.5	2	3	PM	..
LM24-M	3.5	..	8.5	..	..	..	..	..	11.5	..	1.5	D	SC 84A

Max Fe content: 0.25 to 0.35%–Nos. 10 & 11; 0.6 to 0.8%–Nos. 4, 5, 6, 8, 9, 13, 14, 16, 18, 20, 21, 22; 1.3%–No. 24

in view of the advantages in efficient heating, low running costs, automatic temperature control (within ±5 C), uniformity of composition, greater cleanliness, and general quality. They are generally arranged for hand baling but for high outputs larger melting units will supply a number of small holding units.

One firm specializing in die casting of zinc, and quick to see the advantages of a system first seen in operation in the United States, has installed a 60 kw melting furnace of the above type at each end of a line of die-casting machines. Each machine has a 20 kw holding furnace and there is an interconnecting system of resistance heated launders, along which the molten metal finds its own level throughout. The system is cool and clean and metal losses in melting are as low as 0.3-0.4 per cent.

Interest has been shown in a modified form of this same type of furnace, designed as a holding unit for aluminium cold-chamber machines. It has an air-sealed lid gear. Compressed air, introduced above the 300 lb melt for a controlled period, causes the predetermined weight of metal, adjustable between 1/4-lb-20 lb, to be forced up the side of the spout, automatically heated from a point below the surface, and discharged into the die-casting machine at a rate of up to 2 lb per sec. An automatic device compensates for the change in volume within the holding chamber caused by each successive shot. With provision for use of inert atmosphere, the unit can also be used for magnesium die casting.

Surface oxides and scum are completely eliminated, temperature is controlled to the moment of discharge, and the casting cycle can be shortened to give a rate of production comparable with that for zinc-alloy casting. The machine is probably a better proposition for larger types of castings but in any case, conditions in the United Kingdom are such that it is not at present an economical proposition in any operation. Attempts are being made, however, to produce a much cheaper variety of the machine.

Casting Machines

There have been no new developments recently in casting machines. The general position is that the older casting firms are gradually replacing their own designs of machine, which have given excellent service over the years, and substituting one or other of the specially designed production units made by one or two British firms, or American machines being manufactured in the United Kingdom under license.

There is a trend towards the installation of electronic control, supplied by the machine manufacturer or added by the die caster. Some automatic machines are in use for brass casting where dressing and cooling can be carried out by spraying instead of the normal dipping of the blocks and cores. One manufacturer has introduced a specially designed machine for permanent mold casting of brass, incorporating fast speed injection and high pressure to increase density.

Considerable interest has been aroused by reports of the vacuum process in operation in the United States. One United Kingdom firm is hoping to have both a hot-chamber and a cold-chamber machine operating the process shortly. Results of these developments will be watched closely.

Dies

Materials. Die steels vary considerably in composition, each firm tending to favor a particular type and source of supply. Typical compositions of steels used for zinc, aluminum and magnesium alloys are as shown in Table 3.

For copper-alloy casting, a good quality cast iron, preferably low in phosphorus or heat resisting iron, is used for small runs of up to 10,000 or large castings. Heat resisting steel is used for small core pins. For larger runs of over 20,000, high-tungsten, high-speed steel is favored. Nimonic 75 and 80 are also being increasingly used, with runs up to 50,000. It is understood that there is trouble with cracking from quenching with lubricant in brass casting but that excellent results are obtained with aluminum bronze.

Die Manufacture. The standardization of die parts, injector parts, etc., is not very far advanced nor greatly favored. One or two firms have been experimenting with promising results with main die bolsters in nodular cast iron. Among the more recent developments in methods of the die manufacturer, the following are worthy of notice:

Electronic Computer Control of Machine Tools. This involves tape recording of the required movements of a milling or similar machine. The tape is played back to the machine, which automatically carries out the required movements. Some experiments by one firm have indicated the possibilities of considerable saving of time and labor, although difficulties still remain before the process can be fully operated.

Shaw Process. This is a method of producing porous refractory molds suitable for permanent mold casting. The investment solution consists of a mixture of ethyl silicate and industrial alcohol. Five per cent by volume of ammonium carbonate is added, together with a sillimanite refractory filler, and the whole is quickly poured over the pattern. Within two min the solution is gelled by the precipitation of silica, when the pattern can be removed. The mold is coated with a solution of wax in carbon tetrachloride, and fired first with air/gas torches and subsequently in a muffle furnace at 750-850 C (1382-1562 F) to remove all traces of formaldehyde. It is claimed that this process results in considerable saving in cost and time, in accurate and excellent reproduction of detail and improved surface finishes.

Spark Machining. This technique considerably reduces machine/labor time, and enables materials hitherto regarded as uneconomical or unworkable to be used for dies. Moreover, surfaces are produced free of imperfections which could act as crack starters, and without distorted or heat affected areas. The technique cannot at present compete with conventional machining of large cavities in the soft condition, but it is being found economical to rough machine large cavities in soft steel to within 0.01 to 0.015 in. before heat treating and final spark machining.

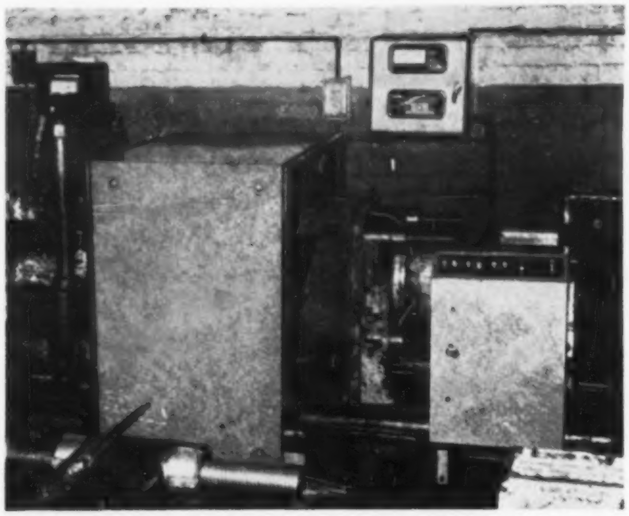

Fig. 2 – Guard in position—instrument panel on wall for automatic die temperature.

Courtesy the Metal Industry

Recent developments have been devoted to increasing stock removal rate, improving finish, and reducing electrode wear and improving methods of electrode manufacture.

Sintered copper and tungsten electrodes are probably the most efficient but are too expensive for general use. 60-40 brass is probably the best material on balance. Tungsten carbide, particularly if formed easily, undergoes slow erosion and has a good penetration factor.

One new type of machine, rated at 4.5 K.V.a., incorporates a controlled pulse generator for the "coarse" or roughing operation, giving a steel removal rate of 400 cmm per min., which is six times that obtained on the previous model. Aluminum electrodes can be used, the wastage ratio being the same as that for the older type of machine. If the metal removal rate could be increased by a further 20 per cent it is estimated that it would be economical to rough out cavities of up to 8 cu. in. completely by spark machining.

The normal random discharge circuit is used for finishing operations, but with recent improvements, intermediate stages are now carried out at higher rates than formally, with reductions in time of 42 per cent in the "medium-coarse" state and 58 per cent in the "medium-fine" state.

A vibrating table has also been added to this type of machine to maintain an axial movement of 0.0003 in. amplitude to prevent swarf build-up, which retards down-feed of the electrode.

Die Temperature Control. The most important new development recently announced in the technical press is that of an automatic system of control. A hole is drilled in a specially selected position in the die, the blind end being within ½-in. of the cavity. Into this hole is fitted a special rapid-response thermometer, spring loading maintaining contact between the button of semi-conducting material and the die block.

The temperature is registered on an instrument panel (Fig. 2) which also contains instruments operating an electrical interlock, which prevents the operational sequence starting before the die temperature is correct. Instruments in a lower panel control the injection and cooling sequences and record the number of shots.

A normal machine has to be set at a time sequence sufficiently slow to avoid die over-heating, with a consequent need for a long cooling time. The new system enables timing sequences to be set for high-temperature operation, allowing the control to bring down the actual operation rate to the optimum for the die, which is usually found to be faster than would normally be attained. At present the control of cooling water flow is in the hands of the operator, but further development is in hand which will enable the water to be turned on automatically as the operating temperature is reached. With this system, if the die temperature falls too low the water would be automatically cut off from the die cavity.

The main advantages claimed for the new technique are:

1. Elimination of early morning scrap, starting up without cooling water and the reaching of optimum casting conditions, say, within 50 shots, when the "all-clear" light is shown and cooling water is switched on.
2. Faster and more consistent operating rates for a die set.
3. Production of the best casting of which die is capable.
4. Maintenance of finish at "plating quality" with improvements in strength of casting.
5. General scrap reduction (up to 50 per cent has been obtained).

Operational Hazards

Z.A.D.C.A. Safety Committee. The subject of operational hazards has recently been studied by this Committee, which has issued the following comments and recommendations in regard to fire hazards and machine guards:

Fire Hazards. Fire resistant hydraulic fluids are replacing ordinary hydraulic oils and giving good results. Conditions for satisfactory use are:

1. The system must be free from scale and paint.
2. Filters are necessary to protect the pump from traces of paint and scale.
3. Seals and packing must be in resistant material.
4. There must be frequent maintenance checks on all joints and flexible pipes to avoid wastage of the high-priced fluid (one firm changes seals and packing every 2/3 weeks).
5. Viscosity and full fire-resistant properties must be maintained by appropriate water additions.

Advantages, apart from the elimination of fire hazards and the absence of toxicity, are:

1. The system works at a lower temperature because of its higher conductivity.
2. Fluid consumption is lower because of better maintenance.
3. Stoppages are fewer.

The lubrication properties could be improved and the slightly higher viscosity of the fluid involves longer warming up periods or the installation of heating elements.

Machine Guards. The Committee has reviewed and made recommendations on precautions against

trapping between dies and moving parts, metal splash and bursting of slugs on die opening.

There must be a mechanically operated restraint device to operate at the beginning of the opening stroke of the platen and to be capable of immediate arrest of reverse motion and of withstanding the full closing force of the machine.

Movable shields are a necessity and should be linked with the hydraulic and not the electrical system. Until the shields are fully closed, mechanical restraint should be fully operative.

A pressure-exhaust device should be directly connected to pressure side of the platen closing cylinder and positively and directly mechanically operated, simply and mechanically interlocked with the shield so that no part of the machine can move under power while the shield is in the unsafe position.

With larger machines and high-locking forces, the exhaust valve can be used to reduce pressure in the closing cylinder when in the safety position to enable the use of relatively light mechanical restraint device. There must, however, be mechanical interlocking.

Inter-locking is necessary to prevent injection before full locking force has been applied to the platen.

There must be full inter-locking control of sequence of operations. This also acts as a secondary safeguard to the major safeguards of inter-locking, as applied above.

These Committee papers have been distributed widely to association members, machine makers, guard makers, and local factory inspectors. A further report is in preparation on tool setting dangers; also accident statistics are being collected.

New Machine Guards. The organization producing the new automatic die temperature control has also produced a machine guard which does not hinder die changes, and which is inter-locked with the die-closure mechanism so that it is impossible to close the dies unless the guard is in position.

The basis of the design is the frame (Figs. 2 and 3) which slides on rollers along a guide bar at the base of the machine. Attached to the base of the frame is an interlock slide. This has at one end a hole into which a pin drops when the guard is closed. Until the guard is closed this pin prevents the operation of the valve for die closure. There is a similar interlock on the injection valve.

The guard panels, of light alloy, are mounted on to this frame with quick release fasteners of the type used on aircraft cockpit covers. An electrical circuit is incorporated into the panel fastenings so that the machine cannot be operated unless the panels are in position. There is thus no possibility of the machine being accidentally set in motion while the guard is open or the panels are not in position.

For die changing, it is only necessary to remove the panels in order to leave ample space for removal and replacement of the die set. In all die-casting machines, alignment of the dies can only be assured if the machine can be opened and closed and for this purpose "inching" is possible while the guard panels are off, using the manual controls. This permits the proper location of the die set, while eliminating any danger of an operator being jammed between the closing dies. The removal of the die panels does not interfere with the setting of the guard inter-locks, so that, on replacement of the guard panels, the system becomes fully effective at once.

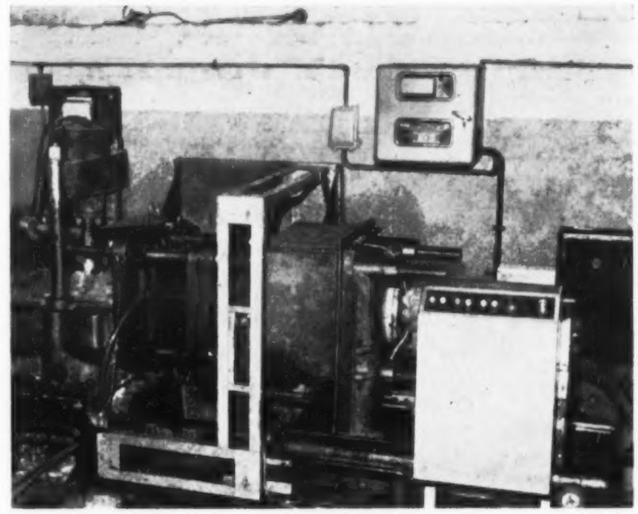

Fig. 3 – Guard frame with panels removed.
Courtesy the Metal Industry

The guard is provided with its own air cylinder operation, inter-locked with the die-closing mechanism as described. The large clearances between guard and die-set allow adequate room for all normal and even elaborate core-pulling facilities. For unusually long cores, special panels can be constructed. Around all edges of the guard is a rolled rubber bead which further protects the operator.

Mechanical Handling

In recent years there has been considerable improvement in the handling of metal and castings, largely stimulated by study of American systems, applied on a more simplified scale because of the comparatively short runs.

Installation A. One jobbing firm, aiming at offsetting increasing costs by greater efficiency of operation, has installed in a new factory a flowline handling system, based on their own planning and on the results of contacts with their American friends. It is the policy of the company to operate the expensive die-casting machines on a night and day basis, while the bulk of the finishing operations are efficiently and economically performed by female labor operating only on day shifts.

In accordance with this policy, the new layout consists of an individual conveyor serving each machine, with a length of nearly 400 ft accommodated in several loops above the trimming lines, with appropriate rises and falls. The conveyor is equipped with hanging "trees" onto which each complete spray of castings is hung in such a way that castings cannot touch each other, thus avoiding any possibility of damage. The conveyor moves the "trees" away from the casting machine into close-packed storage in the roof space.

The first operator on the trimming line can call carriers either from this bulk store from the night shift, or direct from the casting machines, according to the time of day. Finishing lines operate at twice

TABLE 5 – STANDARD MAGNESIUM ALLOYS FOR PERMANENT MOLD CASTINGS

B.S. Spec.	D.T.D. Spec.	Trade Name	Main Alloying Elements per cent: Al	Zn	Mn	Zr	Rare Earth Metals	Th	Conditions	Tensile Properties (minima): 0.1% P.S. t/sq. in.	Tensile Strength t/sq. in.	Elongation %	Related A.S.T.M. Spec.		
1277	..	A.8	8	0.5	0.3	..	..	..	As cast	(4.5)	9.0	2		..	
1278	..	A.8	8	0.5	0.3	..	..	..	Soln h.t	(4.5)	13.0	6	AZ.81	T4	..
1273	..	AZ.91	9.5	0.5	0.3	..	..	..	As cast	(4.5)	8.0	..	AZ.91c	F/B.80	55T
1274	..	AZ.91	9.5	0.5	0.3	..	..	..	Soln h.t	(5.0)	13.0	4	AZ.91c	T4/B.80	55T
1275	..	AZ.91	9.5	0.5	0.3	..	..	..	Fully h.t	(6.5)	13.0	1	AZ.91c	T6/B.80	55T
..	708	ZRE.1	..	2.2	..	0.6	2.7	..	Stabilized	(5.5)	9.0	3	EZ.33A	T5/B.80	55T
..	711A	Z5Z	..	4.5	..	0.7	..	..	As cast	(7.0)	13.0	7	ZK.S1A	F	..
..	721A	Z5Z	..	4.5	..	0.7	..	..	Heat treated	(8.5)	15.0	5	ZK.51A	T5/B.80	55T
..	738	RZ5	..	4.0	..	0.7	1.2	..	As cast	(6.0)	11.0	3	..	..	..
..	748	RZ5	..	4.0	..	0.7	1.2	..	Heat treated	(8.0)	13.0	3	ZE41	T6	..
..	..	C	7.5-9.5	0.3-1.5	0.15 min	..	..	..	As cast	(4.0)	8.0	2	..	..	..
..	..	C	7.5-9.5	0.3-1.5	0.15 min	..	..	..	Soln h.t	(4.0)	12.0	4	..	..	..
..	..	C	7.5-9.5	0.3-1.5	0.15 min	..	..	..	Fully h.t	(5.0)	13.0	1	..	..	..

For die castings, "C" alloy, with 8-10% Al and 0.3-1.5% Zn is used. Beryllium is added to reduce inflammability of the melts.

the speed of casting, the first operation being pressing of each casting from its sprues, runners and vents, when it is dropped on to a fabric belt conveyor for subsequent operations, the sprues etc. passing to the metal reclaiming conveyor. The main trimming lines are planned to be adaptable to as large a range of castings as possible, the average length of run of components being little more than one week.

The problem has been met by the most careful selection of machinery for each line, training of operatives to the variety of tasks, and meticulous attention to the planning of the production program. In this connection, the possibility of using a punch card system for production planning is being considered, taking into account the fact that each die casting job can be classified by the number and type of operations to be performed on it, and that each line has been laid out in regard to length, machinery, number of operations etc., common to a group or range of jobs.

Experience of this new installation to date has shown that cost of handling material within the production lines has been reduced by about 90 per cent, production is achieved in half the floor space required by the traditional layouts. The "through" time for orders has been reduced to one-seventh of that previously required, the damage to articles is negligible, even at a flow rate of 500-600 per hr and the cost of preparatory and finishing operations for subsequent plating has been reduced by at least 20 per cent.

It is estimated that the cost of the conveyor installation when set against the reduced handling labor costs will be recovered in a period of about 3 years. In fact, combined with electronic control of die casting machines and a continuous flow system of molten metal, previously referred to, the new installation provides a highly successful production unit.

Installation B. In a foundry specializing in aluminium-bronze permanent mold castings, the products from the machines are conveyed in batch pans through the whole sequence of finishing operations on power or gravity tracks and, at one stage, an electric truck. At no point is there any lifting by an operator.

Installation C. In this installation, conveyor buckets are automatically tripped at appropriate stages to deposit castings on to a conveyor belt for removal of sprues etc., inspection and sorting, after which they are returned to the empty buckets on the line for further finishing operations. If required, the incoming full buckets may be "shorted" to a second line of operations.

Fettling and Finishing

For the larger runs, press tools are employed for removal of flash, but in the majority of plants the size of orders does not justify this and hand fettling is the usual procedure.

With some designs, particularly where an important dimension comes across a die joint, it is more economical to cast the article to dimensions, which allows for a small final machining operation. In such cases, additional economies can be effected by combining fettling with this machining operation.

In a copper-alloy foundry, effective use is made of alumina or carborundum grit wheels, 12 in.-14 in. diameter by 3/32-in. thick, running at 5,100 rpm and removing runners and risers from 300 castings per hr. Power-driven, hand-operated, grinding and filing tools are used, especially for small recesses and re-entrants, in addition to the conventional methods of fettling. Capstan lathes with specially designed air-operated chucks are used for subsequent machining; power presses are used for broaching, shaving and coining. Thread milling machines are used for internal threading for accuracy and high rates of production.

Industrial Standards

British Standard Specifications. The British Standards Institution is as active as ever in its efforts to standardize industrial alloys, to amend specifications in the light of new knowledge and experience and, where feasible, to reduce the numbers of alloys by rationalization. There is continuing collaboration with Government departments in an effort wherever practicable to meet service requirements with British Standards specifications.

The specifications covering the commercial die and permanent mold casting alloys have been indicated in Tables 4-8. While these do not cover all the alloys used, they account for the bulk of commercial production and thus promote the standardi-

TABLE 6 – STANDARD ZINC ALLOYS FOR DIE CASTINGS

B.S. Spec.	Main Elements – % Cu	Al	Mg	Fe, max	Pb, max	Cd, max	Sn, max	In, max	Ti, max	Related A.S.T.M. Spec.
1004A	0.01 max	3.8-4.3	0.03-0.06	0.10	0.005	0.005	0.002	0.0005	0.001	
	0.15 max	3.5-4.3	0.03-0.08	0.100	0.007	0.005	0.005	..	..	AG.40A/86-53T
1004B	0.75-1.25	3.8-4.3	0.03-0.06	0.10	0.005	0.005	0.002	0.0005	0.001	
	0.75-1.25	3.8-4.3	0.03-0.06	0.100	0.007	0.005	0.005	..	..	AG.41A/86-53T

zation of products, and assist designers considerably in their choice of materials.

For zinc-alloy die castings, B.S. 1005, "Sampling and Analysis of High Purity Zinc and Zinc Alloys for Die Castings", and B.S. 1225, "Recommended Methods for Polarographic and Spectrographic Analysis of High Purity Zinc and Zinc Alloys for Die Casting" have been of value.

British Standards Code of Practice C.P. 3001 is concerned with zinc-alloy die casting and covers compositions and properties, design considerations, working practices and inspection. Appendices of the code deal with the weight test and list mechanical properties and dimensional changes on aging.

The quality of zinc-alloy die casting is further safeguarded by the British Standard Certification Mark Scheme introduced in 1954, five years after the introduction of a similar scheme in the United States. Under this scheme, die-casting firms may be licensed to use the official B.S. Kite mark on their castings as a guarantee of their compliance with B.S. 1004. The 40 firms at present participating in the scheme have to provide analytical control to the satisfaction of the B.S.I. inspectors. Similar schemes are in operation in France and Germany.

Engineering Standards for Die Castings. These standards were prepared by the Technical Committee of the Zinc Alloy Die Casters Association, in collaboration with the American Die Casting Institute, and with the assistance and approval of the Technical Committee of the Light Metal Founders Association.

Recognizing that fine tolerances need be held as a rule on only a few dimensions in any one casting, these standards lay down for aluminum, magnesium and zinc alloys, tolerances which will be a guide to production at the most economic level consistent with fast, uninterrupted production, maximum die and tool life and low maintenance costs.

Inspection and Quality Control

For chemical analysis, increasing use is being made of the spectrograph, and in a few cases direct reading instruments have been installed.

Radiographic examination, visual or photographic, is frequently employed in determining optimum die design and technique of production for a new component and in the early stages of production. Radiographic examination is also sometimes used as a check on batch production in conjunction with sectioning and break-up. This examination is facilitated by the current availability at an economic price of radio isotopes.

A weight test is sometimes called for, especially where failure from porosity could result in accidents or serious machine failure; the latest type of weighing machine can deal with 800-1,000 parts per hr. Impressions must be within, say, 2-1/2 per cent of an agreed figure, based on an acceptable degree of soundness determined by radiographs or sectioning.

Normal procedures operate for visual examination, crack detection, dimensional and distortion checks, and mechanical testing.

Surface Treatments

These are usually of a conventional type, such as chromate passivation of zinc, acid chromating (for commercial castings), alkali chromating (for aircraft components) of magnesium, electro-plating, etc.

With anodic oxidation, it is normally impossible to obtain an attractive finish. Under experimental conditions one firm has obtained a high degree of polish by anodizing after mechanical and chemical brightening, using super-pure aluminium. The technique is not yet in production.

The British Non-Ferrous Metals Research Association has been investigating the causes of blistering of nickel-chromium plated zinc-alloy die castings.

TABLE 7 – STANDARD COPPER ALLOYS FOR DIE AND PERMANENT MOLD CASTINGS

B.S. 1400	Main Elements – % Cu	Sn	Al	Pb	Fe	Mn	Ni	Zn	Tensile Properties: Tensile Strength t/sq. in.	Elongation %
(B4-C	59.0***	-	0.5**	-	-	-	-	Rdr	18 min.	25 min.
(*DCB.-1	59.0-63.0	-	0.5**	0.1**	-	-	-	Rdr	-	-
(B5-C	61.0***	0.5-1.5	0.5**	0.1**	-	-	-	Rdr	20 min.	20 min.
(*DCB-2	61.0-65.0	0.5-1.5	0.5**	0.1**	-	-	-	Rdr	-	-
*DCB-3	58.0-63.0	0.5**	1.0**	0.5-2.5	0.25**	-	-	Rdr	-	-
HTB1-C	55.0***	1.5**	2.5**	0.5**	0.5-2.0	3.0**	1.0**	Rdr	-	-
AB1-C	Rdr	-	8.5-10.5	-	1.5-3.5	1.0**	1.0**	0.5**	32	20
AB2-C	Rdr	-	8.5-10.5	-	3.5-5.5	1.5**	4.5-6.5	0.5**	40 (0.1% ps-16)	12

*Draft revision of B.S. 1400
**max
***min

Fig. 4 – Service blisters on a plated car door handle.
Courtesy British Non-ferrous Metals Research Association

TABLE 8 – CLASSIFICATION OF SERVICE DIE CASTINGS ACCORDING TO THEIR APPLICATION

Class	Aircraft	Armament Stores
1	A part, the failure of which in flight, landing, or take-off might be the direct cause of: a) structural collapse b) loss of control c) failure of motive power d) unintentional operation of or inability to operate any services or equipment essential to the safety or operational function of the aeroplane or e) injury to any occupant. (If failure would only lead through a second unlikely event e.g. a broken aerial mast jamming the tail unit controls, the part is not within the definitions of Class 1).	An explosive store, or component of an explosive store, the failure of which at any time would lead to a serious accident or to the loss of serviceability of an important item of service equipment. or A non-explosive store, or component, the failure of which in use might be the direct cause of an accident or the loss of an important item of service equipment. (If the failure of a non-explosive store or component would only lead to danger through a second unlikely event the part does not come within the definitions of Class 1).
2	A part, store, or component, which is stressed in service, but which is not covered by the terms of Class 1.	
3	A part, store, or component, which is unstressed or only lightly stressed, and which is not covered by the terms of Class 1.	

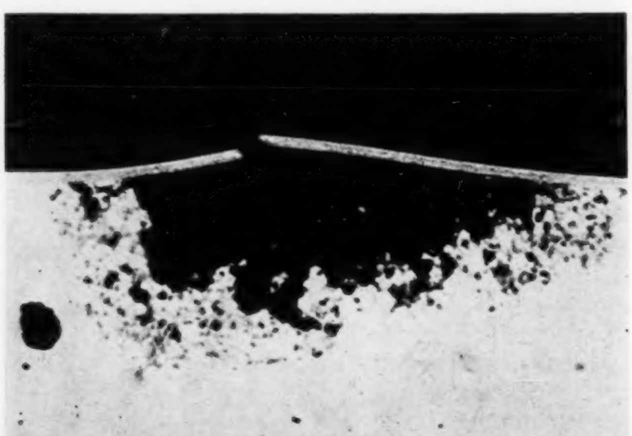

Fig. 5 – Section cut through a blister showing penetration of the plating and internal corrosion.

The results of work on process blistering occurring during or shortly after plating are not yet released for publication.

In a study of blistering occurring during service, a wide variety of components plated at different times over six months by two firms were exposed in the atmosphere. Every blister that formed was found to be associated with a small hole in the coating, and every blister opened up was found to be full of zinc corrosion product (Figs. 4 and 5). Thus the service performance of plated zinc was found to be determined by the resistance of the coating to penetration.

The current British Standard specification requires a minimum thickness of 0.0003 in. of copper and 0.0006 in. of nickel. While variation of the copper thickness was shown to have no effect, increase of the nickel coating to 0.0009/0.001 in. resulted in resistance to penetration in normal environments, and the specification is being amended accordingly.

The possibility of producing an anodic coating on die-cast zinc alloy has also been investigated. The initial zinc oxide film (greyish-white and porous) was produced by anodizing in a solution of sodium hydroxide and sodium carbonate. It was then heated in an autoclave in silicate solution to seal and give durability. Unfortunately, only one uniform, greenish-yellow color was obtained by dying, and flow lines were very marked.

After several weeks' exposure in a severe industrial atmosphere the appearance of the dyed coating had deteriorated and the condition was poorer than that of the undyed coating. The technique has been abandoned as of no practical interest and work on other methods is now in progress.

PRODUCTION FOR THE ARMED FORCES

War Production

During World War II, Great Britain relied to a considerable extent on the production of die castings to fulfill her ammunition requirements, thereby achieving important economies in material and manpower. As aluminum was in prior demand for aircraft purposes, only one ammunition component, a top-fuse cap, was die cast in light alloy. The remaining die castings were in zinc alloy. During the peak period of production, 7 million components of mortar bomb fuses, artillery fuses, mechanical time fuses, and hand grenades were being die cast per week.

Many components produced by die casting had formerly been pressed or machined parts, but eventually the necessity and advantages of designing for die casting were recognized.

Current Production

Since the war, the re-armament period and the Korean campaign, production requirements have decreased considerably.

Zinc alloy continues to be used for the bulk of ammunition components of the type produced in World War II. However, with the greater availability and more economic price of aluminum and, in some cases, the need for weight saving, the use of aluminum alloys has been extended for some die-cast

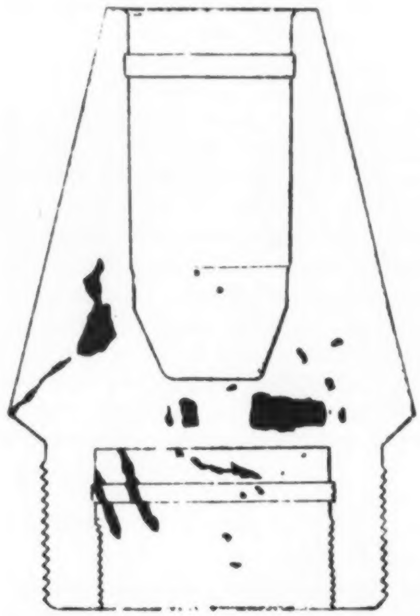

Fig. 6 – Left–Sectioned body showing porosity. Earlier trials.

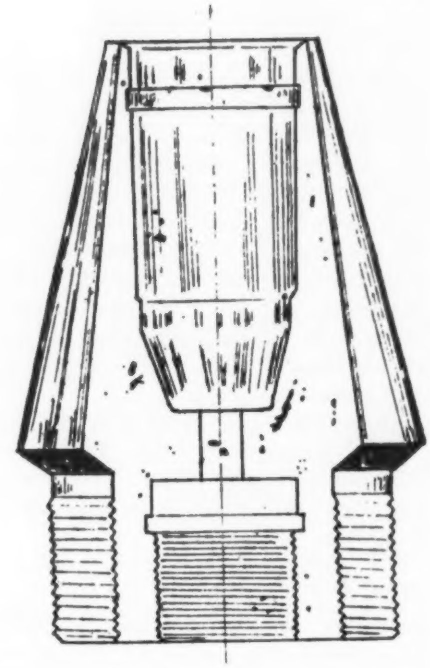

Fig. 7 – Right–sectioned body showing porosity. Later trials.

components such as spacers and boosters on off-shore orders, ammunition chargers, bomb arming vanes, and ammunition box supports.

Magnesium alloys and particularly aluminum alloys continue to be used for aircraft components.

Recently, there have been attempts to produce a large leaded-brass fuse body by pressure die casting on a horizontal machine (400 tons locking pressure, injection pressure 5.4 tons per sq. in. and variable injection speed over an 18 in. stroke) instead of by hot pressing or machining of extruded bar.

After trials with different steels, an American die steel, containing 0.35 per cent C, 3.5 per cent Cr, 10 per cent W, 0.2 per cent V, and subject to special heat-treatment sequences and precautions to keep machining and heat stresses to a minimum, was the most successful. It was estimated a die life of at least 20,000 castings would have been possible in spite of a certain amount of crazing. As the casting had to be subsequently machined, surface condition was not of special importance in this instance.

Unsoundness remains the major problem, although improvements obtained during the trial are indicated by Figs. 6 and 7. Had it been possible to continue with the trial, a vertical machine would probably have been used in the hope of improving soundness still further.

Although the requisite standard was not obtained with the fuse body, the experiments were useful in proving that a free machining brass can be die cast, and it seems certain that smaller brass ammunition components could be satisfactorily die cast in brass. In an emergency, limited extruded rod capacity might make this necessary. It is estimated that die casting would be a little more costly than production from extruded rod or hot pressing.

A complicated thin-walled initiator casing has been successfully die cast in leaded brass. In view, however, of the greater weight, the more complex manufacturing process and more careful inspection required, the higher costs, the component will continue to be produced in zinc alloy.

All zinc alloy die castings for service purposes are now ordered to Ministry of Defense Specification DEF 17, "Zinc Alloy Pressure Die Castings (Control of Manufacture and Inspection)", which was sponsored by the advisory committee (die casting). This specifies the material to be used (B.S. 1004, Alloy A), and also covers types of casting machines, approval of the products of new or modified dies, dimensions and finish, chemical analysis and weight, and soundness tests. The specification features are:

1. All castings are classified according to the extent to which a failure of the casting would cause a serious accident (Table 8).
2. Specified scrap is permitted in varying quantities according to the casting classification.
3. Tin, cadmium, lead and indium are rigidly excluded from the casting area.
4. The casting machine must inject the metal into the die by power operated plunger.
5. Thermostatic control of metal in the melting pot is required.
6. Initial castings made after starting machines from cold are scrapped.

Control of Manufacture and Inspection

In 1941, under the aegis of the Ministry of Supply, an advisory committee (die casting), consisting of representatives of the service departments (army, navy and air force) and the die casting industry, was formed to deal with problems of design, production, inspection and control of quality of zinc alloy die castings. The terms of reference were subsequently widened to cover die and permanent mold castings in any alloy.

In furthering its principal object the committee directed its activities mainly to:

1. Specifications.
2. Improvement of inspection facilities and standards.
3. Preparation of a handbook on die and permanent mold casting.
4. A program of tests on die and permanent mold casting alloys at various temperatures.

Specifications

Zinc Alloy Die Castings. During World War II (1941), the committee collaborated with the British Standards Institution in their production of B.S. 1003 (for high-purity zinc 99.99 per cent) and B.S. 1004 (for two die-casting alloys and die castings). This group set very low limits for lead, tin and cadmium, the presence of which in excess amounts had caused embrittlement and failure of castings in the early phases of the war. The specification was amended in 1955 by the introduction of limits for thallium and indium at 0.001 per cent and 0.005 per cent respectively.

Aluminum Alloy Die Castings. These are now covered by specification DEF 30, "Aluminum Alloy Pressure Die Castings (Control of Manufacture and Inspection)", which was also sponsored by the advisory committee.

Where appropriate, this specification is similar to DEF 17. The materials are not specified but in an appendix, chemical compositions, mechanical properties and general remarks are given in respect to three alloys, B.S. 1490-LM-2M, 6M, 24M, specially recommended for service application. The proportion of scrap used is not limited, but safeguards against undesirable contamination are included. The use of hot-chamber machines is precluded as a precaution against excessive iron pick-up. Approval of products of a new or modified die, dimensions and finish, chemical analysis, tensile end soundness tests are also covered.

Magnesium and Copper Base Alloy Die Castings. The use of these materials for service die castings has been relatively small, and it has not been considered necessary to draw up special service standards as for zinc and aluminum. The materials used are, in general, covered by British Standards.

Permanent Mold Castings. The use of permanent mold aluminum-alloy castings for service purposes has been extensive. For armament applications, however, no special specification has been drawn up, materials to B.S. 1490 being used. Inspection requirements are in the main more closely aligned with practice for sand castings, and have not therefore been of concern to the advisory committee (die casting).

Steps are currently being taken to ensure that all forms of castings are classified in accordance with Table 8 in order to assist the founder and inspector on the degree of inspection required.

Improvement of Inspection Facilities and Standards

During the war, the committee initiated a scheme, which is still in being, whereby sample castings from new or modified dies are critically examined by x-rays before bulk production is approved. Radiographic equipment was installed in foundries with high output, and at suitably located Government inspection laboratories throughout the country.

At most foundries a casting or spray is submitted to the government inspectorate as soon as the founder considers the standard of the pre-production run is up to requirements of the contract. The casting is radiographed, and if accepted, the radiograph is retained by the inspectorate. If the casting is unacceptable the radiograph is sent to the foundry.

After production commences, sample castings are selected from each machine on a minimum laid down for the day or production run. These are radiographed and compared with the standard. Radiographs showing a falling off in standard are sent to the founder for remedial action.

This periodic x-ray of castings in the course of production is called for through the medium of the "Inspection Instructions" issued by the inspectorates. These detailed instructions, drawn up partly as a result of committee efforts, are used both by the contracting founder, and the official inspector, and are an important factor in ensuring the maintenance of a high standard of quality of castings for service purposes.

Preparation of "A Handbook on Die Castings for Service Designers and Inspectors"

During the War, the committee published a small brochure, "Zinc Alloy Pressure Die Castings for Service Application", which briefly indicated the advantages of using die castings, and gave some data on the mechanical properties at normal and low temperatures, information on corrosion resistance, and service experience with dropping trials to test impact resistance of castings *in-situ*.

In 1953, the committee published a larger handbook aimed at assisting, in particular, the designer, 1) to appreciate fully the advantages and limitations of the die and permanent mold casting processes, 2) to assess the suitability of a particular component for production as a die casting or permanent mold casting, 3) to make the best choice of materials available, and 4) to design a component so as to take full advantage of the potentialities of the process and material chosen.

Although specifically prepared for designers and inspectors in service departments, the handbook was made generally available through Her Majesty's Stationery Office. To date some 1,000 copies have been sold. It includes chapters on the die and permanent mold casting processes; dies; alloys—zinc, aluminum, magnesium, copper, tin, lead and cast iron; design of castings; service inspection and useful tables of compositions, physical and mechanical properties, tolerances, drafts, tapers, etc.

The Tensile and Impact Properties of Die and Permanent Mold Casting Alloys at Various Temperatures

During the post World War II re-armament period, the committee decided to sponsor a program of tests to provide designers with reliable data on the mechanical properties at temperatures ranging from −55 C to +70 C (−67 to +158 F) of commercially available die and permanent mold casting alloys which had been cast by industry under similar conditions. The materials tested comprised 2 zinc, 16 aluminum, 3 magnesium, and 5 copper alloys, which, together with the heat treated materials, made the total number of variants 37.

The die-cast tensile test pieces and the unnotched impact test pieces were to the A.S.T.M. design. Im-

pact test pieces to B.S. 131 (Fig. 1) with a standard Izod notch were also included.

The tests were carried out six months after the date of casting, and some selected materials are being tested after three years aging at 18 C (64 F).

Test results to date are summarized in Table 9 and Figs. 8-12, reproduced from an unpublished Ministry of Supply report by H. Waterhouse, 1958, which deals with the program in detail. The most important findings of the investigation were:

1. The alloys tested covered a range of tensile strengths from 11-47 tons per sq. in., of elongation

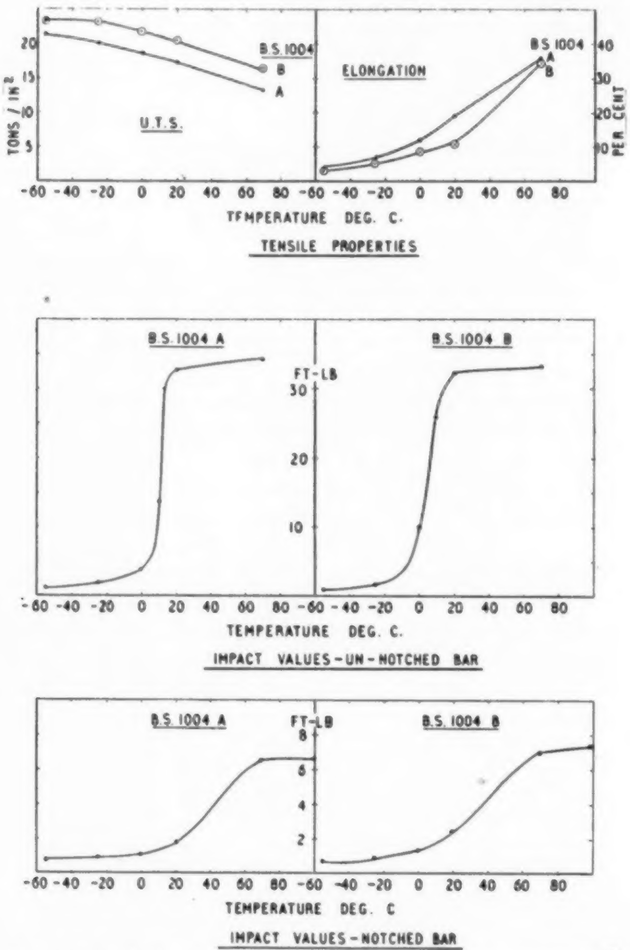

Fig. 8 – Variation of properties with temperature pressure die cast zinc alloys.

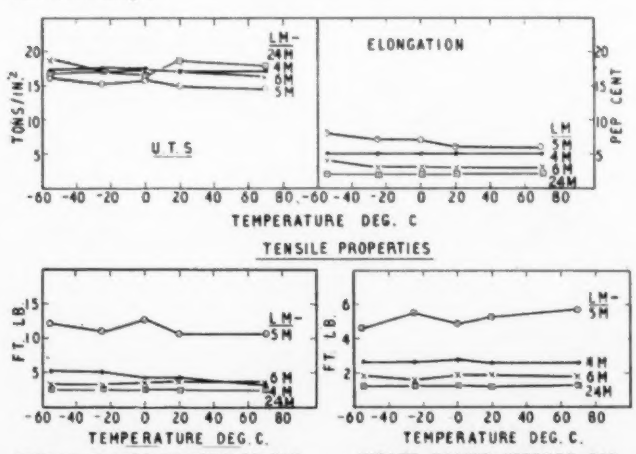

Fig. 9 – Variation of properties with temperature pressure die cast aluminum alloys.

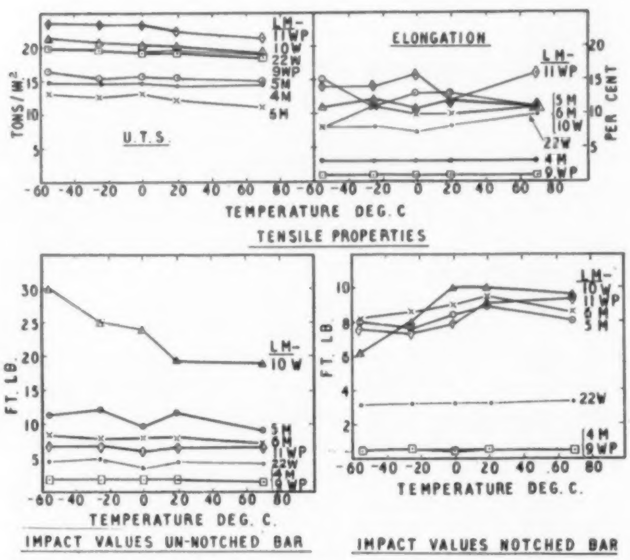

Fig. 10 – Variation of properties with temperature gravity die cast aluminum alloys.

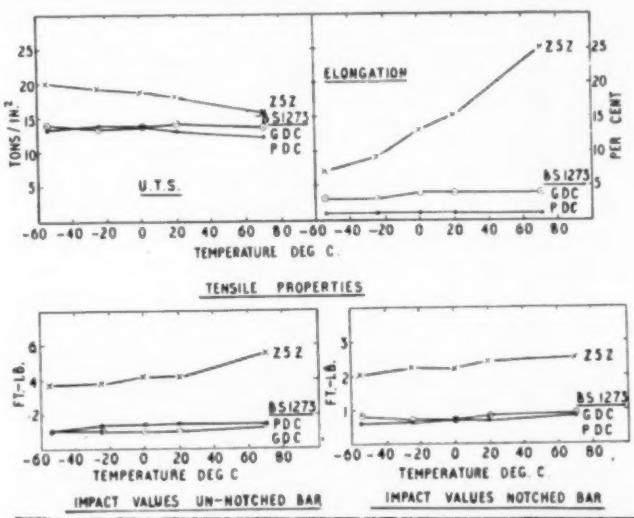

Fig. 11 – Variation of properties with temperature pressure and gravity die cast magnesium alloys.

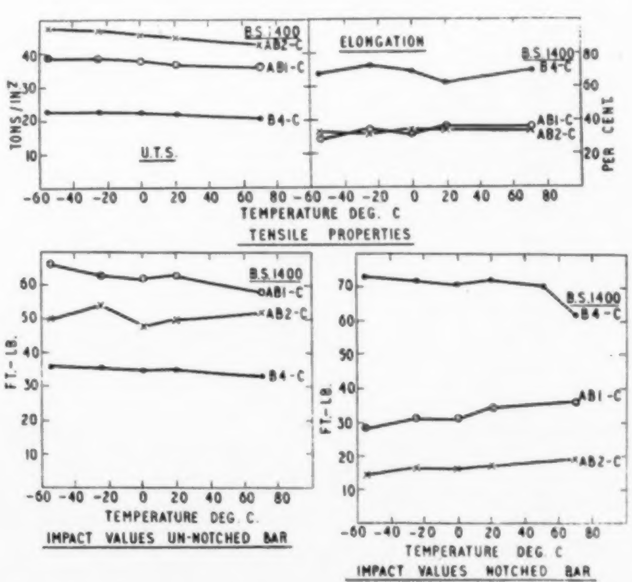

Fig. 12 – Variation of properties with temperature gravity die cast copper alloys.

TABLE 9 – SUMMARY OF AVERAGE RESULTS OF TENSILE AND IMPACT TESTS ON DIE CASTING ALLOYS[a] (SIX MONTHS AFTER CASTING)

Type of Alloy	Specification B.S	Specification STA. 7	Specification D.T.D.	Casting Process for Test Bar	Tensile Properties: T.S. tons/in.², at C −55	−25	0	+20	+70	Elongation, % on 2 in. at C −55	−25	0	+20	+70	Impact Values, ft. lb.: Un-notched Bar, at C −55	−25	0	+20	+70	Notched Bar, at C −55	−25	0	+20	+70
Zinc	1004A	ZA.1		PDC	21.4	20.1	18.8	17.4	13.4	4	7	12	19	36	1.0	1.8	3.6	33	34	0.7	0.8	1.0	1.7	6.5
	1004B			PDC	23.2	23.1	21.9	20.5	16.5	3	5	9	11	35	0.8	1.5	9.8	32	33	0.65	0.85	1.3	2.4	7.0
Aluminum	1490																							
	LM-1-M	AC.1		GDC				13.0					1					1.1					0.6	
	LM-2-M	AC.2		PDC				20.0					2					2.1					1.0	
	LM-4-M	AC.4	424	PDC	17.4	17.5	17.5	17.1	17.1	5	5	5	5	5	5.1	5.0	4.2	4.3	3.2	2.6	2.6	2.8	2.6	2.6
	LM-4-M	AC.4	424	GDC	14.7	14.5	14.6	14.2	14.3	3	3	3	3	3	1.8	1.8	1.8	1.8	1.6	1.2	1.2	1.3	1.3	1.3
	LM-5-M	AC.5	165	PDC	16.1	15.1	15.8	14.8	14.5	8	7	7	6	6	12.3	11.0	12.8	10.6	10.6	4.6	5.5	4.9	5.3	5.7
	LM-5-M	AC.5	165	GDC	16.4	15.2	15.6	15.4	14.9	15	11	13	13	11	11.3	12.1	9.5	11.6	9.0	7.9	7.7	8.4	8.9	8.1
	LM-6-M	AC.6		PDC	18.7	17.2	17.4	17.3	16.4	4	3	3	3	3	3.4	3.3	3.6	3.8	3.6	1.8	1.6	1.9	1.9	1.8
	LM-6-M	AC.6		GDC	13.0	12.6	12.8	12.1	11.2	8	11	10	10	11	8.4	7.9	8.0	8.1	7.2	8.3	8.6	9.0	9.5	8.6
	LM-8-P	AC.8A	722	GDC(HT)				12.6					6					2.2					1.9	
	LM-8-W	AC.8B	727	GDC(HT)				15.9					6					5.6					2.9	
	LM-9-P	AC.9A		GDC(HT)				13.2[c]					2					2.0					2.2	
	LM-9-WP	AC.9B	245	GDC(HT)	19.8	19.5	19.1	19.1	18.4	1	1	1	1	1	1.9	2.0	1.9	1.8	1.7	1.0	1.2	0.9	1.2	1.1
	LM-10-W	AC.10		GDC(HT)	21.4	20.6	20.4	20.1	19.1	11	12	11	12	11	30	25	24	19	19	6.5	8.0	10.1	10.1	9.1
	LM-11-W	AC.11A	298	GDC(HT)				19.4					15					14.5					11.6	
	LM-11-WP	AC.11B	304	GDC(HT)	23.5	23.3	23.3	22.4	21.3	14	14	16	12	16	6.8	6.9	6.1	6.8	6.7	7.6	7.4	7.9	9.1	9.4
	LM-12-WP	AC.12		GDC(HT)				21.4					1					1.5					0.7	
	LM-13-WP	AC.13A		GDC(HT)				22.3					1					1.9					0.7	
	LM-13-WP(S)	AC.13B		GDC(HT)				15.3					2					3.0					1.0	
	LM-14-WP	AC.14A		GDC(HT)				21.9					3					3.2					1.5	
	LM-14-WP(S)	AC.14B		GDC(HT)				15.3					8					2.9					2.6	
	LM-15-WP	AC.15		GDC(HT)				20.1[d]					3					2.1					2.5	
	LM-22-W	AC.4A		GDC(HT)	19.8	19.5	19.1	19.4	18.9	8	8	7	8	10	4.4	4.7	3.5	4.6	4.3	3.1	3.2	3.2	3.2	3.4
	LM-23-P	AC.7		GDC(HT)				13.0					5					4.8					1.8	
	LM-24-M			PDC	16.7	17.4	16.8	18.6	17.9	2	2	2	2	2	2.6	2.7	2.5	2.4	2.7	1.2	1.3	1.2	1.2	1.3
Magnesium	1273			PDC	13.4	13.8	13.8	13.1	12.2	1	1	1	1	1	1.0	1.3	1.4	1.4	1.4	0.6	0.6	0.7	0.7	0.8
	1273			GDC	14.0	13.6	13.8	14.1	13.5	3	3	4	4	4	1.0	1.0	1.0	1.0	1.2	0.8	0.7	0.7	0.8	0.9
	1274			GDC(HT)				19.1					13					4.5					2.1	
	1275			GDC(HT)				19.9					7					2.6					0.9	
	—	(Z5Z)[b]	721	GDC(HT)	20.1	19.2	18.9	18.0	15.8	7	9	13	15	25	3.7	3.8	4.2	4.2	5.6	2.0	2.2	2.2	2.4	2.5
	—	(ZRE1)[b]	708	GDC				11.6					6					2.3					0.8	
Copper	1400																							
	-B4-C	CZ.14		GDC	22.6	22.6	22.0	21.4	20.5	68	72	69	62	70	36	35	35	35	33	73	72	71	72	62
	-B5-C	CZ.15		GDC				20.6					47					35					26	
	-AB1-C	CA.3	174	GDC	38.5	38.2	37.6	36.7	35.8	29	34	32	36	35	66	63	62	63	58	28	31	31	34	36
	-AB2-C	CA.4	412	GDC	47.1	46.2	45.4	44.6	43.0	33	32	34	35	34	50	54	48	50	52	14	16	16	17	19
	—	CX.10		GDC				43.7					9					25					10	

(a) The actual compositions are shown in Table 4 and the detailed test results in Table 7.
(b) Commercial designation.
(c) Result below specified minimum (15 tons/in.²)
(d) Result below specified minimum (21 tons/in.²)
The impact values for alloys c and d are considered to be reliable.

figures up to 70 per cent, and of impact values up to 70 ft-lb.

2. The effect of increasing temperature from −50 C to +70 C (−67 F to +158 F) did not produce any recognizable trends beyond a slight general falling of tensile strength, except as given in the following paragraphs.

Zinc Alloys. The impact strength (unnotched bar) decreased from 34 ft-lb at 70 C (158 F) to 1 ft-lb at −55 C (−67 F).

Aluminum Alloys. Permanent mold casting alloy B.S. 1490-LM10-W increased in impact strength from 19 ft-lb at 70 C (158 F) to 30 ft-lb at −55 C (−67 F) with an unnotched bar and conversely decreased from 10 ft-lb at 20 C (68 F) to 6.5 ft-lb at −55 C (−67 F) with a notched bar.

Magnesium Alloys. The tensile strength of permanent mold casting alloy DTD.721 increased from 16 tons per sq. in. at 70 C (158 F) to 20 tons per sq. in. at −55 C (−67 F), while the elongation decreased from 25 to 7 per cent.

Copper Alloys. Permanent mold cast 60-40 brass showed a distinct drop in tensile strength from 72 tons per sq. in. at 20 C (68 F) to 62 tons per sq. in. at 70 C (158 F).

3. The effects of methods of casting on three aluminum alloys and one magnesium alloy die cast and also cast in a permanent mold, were wholly inconsistent.
4. The variation in results did not generally agree with difference in the degree of unsoundness revealed by radiographic examination.

The results of a particular alloy at a particular temperature frequently showed a high degree of scatter and this probably masked the effects of temperatures where these were small. This applied more especially to the elongation and impact values than to the tensile strengths. The copper alloys were the most consistent materials. There was little to choose between the consistencies of the die and permanent mold cast forms of the four alloys produced by both methods.

5. The zinc alloys showed no appreciable change after 3 years aging. Other tests on aged alloys are not yet complete.

Prior to the formation of the advisory committee (die casting), zinc alloy die castings in particular were not held in high esteem for important applications. This was due to: a lack of understanding of their properties, to some unfortunate experiences resulting from the use of impure metal, and to inferior production of individual firms which did not have the necessary plant and technique.

The activities of the committee outlined above have undoubtedly resulted in focusing attention on the use of die and permanent mold castings for service applications and in a general raising of production standards throughout the industry. Moreover, designers have been provided with more reliable information which enables them to assess the suitability of die castings for particular applications, and greater use is now made of facilities for discussing proposed new designs of die or permanent mold castings with the manufacturers.

ACKNOWLEDGMENT

The authors desire to thank departmental colleagues and many individuals in industry for their valuable help in providing much of the information included in the paper.

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HIGH STRENGTH ALUMINUM ALLOY X357 PROPERTIES AND AGING PRACTICES

By

Alan B. DeRoss*

ABSTRACT

This paper discusses the heat-treating practices and mechanical properties of a high-purity aluminum casting alloy X357. This alloy is basically an aluminum-silicon-magnesium type. It develops exceptionally high tensile and yield strengths with good ductility after heat treatment. High temperature solution and aging cycles are used. Separately cast test bars show yield strength to be in the range of 43,000 psi and ultimate strength above 50,000 psi.

Established foundry techniques are used in melting, fluxing and pouring. High purity alloy X357 exhibits all the desirable foundry characteristics associated with castability, machinability, dimensional stability, and corrosion resistance.

INTRODUCTION

It has become increasingly evident that aluminum casting applications in structural and highly stressed components are facing a definite challenge for the replacement of other more expensive fabricated units. An aluminum casting alloy designed to meet the stringent qualifications imposed by the design engineers would have to exhibit high tensile and yield strengths, have good ductility and dimensional stability, exhibit excellent foundry characteristics with good machinability and corrosion resistance.

There are several aluminum casting alloys available[1] that exhibit high tensile strengths and high ductility, however, most of these alloys have low yield strengths. There are also those alloys that develop high yield points but exhibit very low ductility levels. Almost all of these alloys have the disadvantage of poor castability, thus limiting their successful application to more complex casting designs.

Aluminum casting alloy X357 was developed to fill the need for a higher tensile–higher yield strength casting alloy with good ductility. The alloy should find ready application where high yield strength is of prime concern such as in highly stressed aircraft and missile structures, high velocity blowers and impellers. Because of the higher strength levels developed with X357, it is possible to design castings with smaller cross-sectional areas to reduce weight without sacrificing strength. A significant advance is that the properties of medium-strength forging alloys are within the range of the permanent mold properties of X357.

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The high-strength potential of alloy X357 is made possible by limiting impurities to as low a value as practicable, while making available an alloy that is commercially practical from a metal purity standpoint. For example, it is well known that iron has a detrimental effect on the ductility of aluminum-silicon-magnesium alloys.

According to Mondolfo[2] and Bonsack[3], a beta iron-silicon intermetallic compound occurs in these alloys in the form of large thin needles and plates. Like most intermetallic compounds, it is brittle and reduces ductility in proportion to the amount present. Because of its effect on ductility, the iron in alloy X357 is limited to a maximum of 0.15 per cent. The microstructure of high-purity aluminum alloy X357 taken from a casting is shown in Fig. 1.

It is apparent from the photomicrograph that very little beta iron-silicon constituent is in evidence. Also, good modification of the silicon eutectic structure is exhibited although no attempt was made at artificial modificaion. The alloy ingot specification for high purity X357 is shown in Table 1 along with—a typical chemical analysis of the alloy used in this investigation. Of significant interest other than the low iron content, is the low concentration of other impurities.

This specification it typical of the excellent quality of primary material available on the market today. Since the strength of aluminum-silicon-magnesium alloys is developed by the formation of an intermetallic compound, magnesium silicide, it seemed a natural step with high purity material to increase the magnesium content to a higher value than that normally found in other aluminum-silicon-magnesium alloys used in sand and permanent mold casting. In effect, the increase in magnesium should raise the yield and tensile strengths, and still leave the alloy with a good ductility level.

The higher purity of alloy X357 permits the use of more complete artificial aging. The full potential strength values could be developed in this way without approaching brittleness. By using high solution heat-treating temperatures and high aging temperatures, the permanent mold properties were developed to 52,000 psi tensile strength, 43,000 yield strength, and 5 per cent elongation. Those for sand cast were

50,000 tensile strength, 43,000 yield strength, and 2 per cent elongation.

EXPERIMENTAL PROCEDURE

In many instances development work performed in a laboratory may exhibit results not readily obtainable in the production field. This is no criticism of laboratory work, since there are definite functions that cannot be accomplished elsewhere. However, production techniques are not readily reproducible in the laboratory. For this reason all the melting and casting of test specimens for this investigation was carried out in several foundries throughout the country using production equipment under production conditions. In all cases, established melting and casting techniques were followed throughout this investigation.

All furnace charges were alloy ingot and were melted in oil- and gas-fired crucible-type furnaces with either silicon-carbide, clay-bonded graphite, or refractory-coated iron crucibles. Approximately 300 lb of aluminum was melted at one time. Fluxing was accomplished in some cases using chlorine gas. Hexachloroethane compounds were used in other cases. The actual fluxing time was approximately one min for each 100 lb of material.

Casting temperatures for both sand-cast and permanent-mold castings averaged approximately 1300 F (705 C) to 1320 F (715 C). Average operating temperatures of the permanent molds were approximately 625 F (330 C). Sand-cast test specimens were cast in natural-bonded green molding sand.

Standard test bar designs were used for both sand and permanent mold test specimens. In order to gain a good cross-esction of test bar mold designs, no attempt was made to use a single gating or mold design. It should be of interest to note that gating designs varied considerably, and mold designs contained one to six cavities.

Solution heat treatment was performed in a circulatory air furnace. The test specimens were held at a temperature of 1000 F to 1010 F (538 C to 543 C) plus or minus five degrees, for 12 hr. They were then quenched into water which was at a minimum temperature of 180 F (82 C). Aging cycles were accomplished in the same furnace at 320 F (160 C), 350 F (177 C), 400 F (205 C), and 450 F (232 C). Time at temperature varied from two hr to 10 hr. No holding periods between quenching and aging cycles were used.

OBSERVED DATA

It is important with high purity alloy X357 that foundry melting practices be controlled to eliminate the possibility of iron pickup or other impurities from equipment or foreign contaminates. The chemical composition of the alloy should be maintained as close to the nominal amount as possible. This is particularly true of the magnesium content 0.50 per cent nominal. Observations by the author indicate that a significant reduction in tensile and yield properties can result if the magnesium content is allowed to drop below 0.45 per cent.

Fluxing with chlorine gas is desirable although it must he well controlled as excessive chlorine gas fluxing will remove magnesium and thereby reduce the net amount of magnesium remaining in the casting. Although chlorine gas is an excellent fluxing agent, its use in high purity X357 is not altogether necessary. Aluminum chloride, hexachloroethane, and other generally accepted chemicals are suitable. Observation indicates that high-purity alloy X357 has excellent mold filling characteristics, machinability, dimensional stability, and corrosion resistance.

Aging curves for alloy X357 are shown in Figs. 2, 3, 4, and 5.

The curves indicate the highest strengths were obtained with an aging cycle of six hr at 350 F (177 C) for both permanent mold and sand cast. Varying aging temperatures from 320 (160 C)-450 F (232 C) at a fixed time of six hr indicated the best aging temperature to be 350 F (177 C) for both permanent mold and sand cast. These curves also reveal that the permanent mold tensile and yield

TABLE 1 – X357 ALLOY INGOT SPECIFICATION AND TYPICAL ANALYSIS

Element	X357 Specification	Typical Analysis
Cu	0.05 Max	0.007
Si	6.5 - 7.5	7.02
Fe	0.15 Max	0.11
Mg	0.45 - 0.60	0.54
Zn	0.03 Max	0.01
Mn	0.03 Max	0.002
Ti	0.10 - 0.20	0.16
Other Elements Each	0.03 Max	
Other Elements Total	0.10 Max	

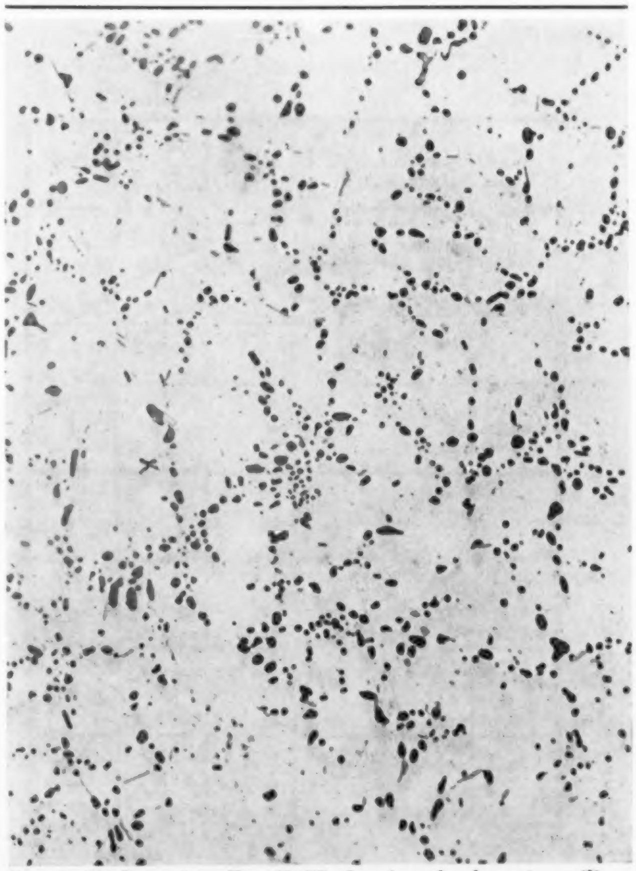

Fig. 1–High purity alloy X357 showing the beta iron-silicon constituent (light-needle shape). Unetched, ×250, section from casting. T-6 condition.

properties are substantially the same as the sand cast properties. However, elongation values follow a normal course and maintain a respectable difference. The fact that the sand-cast elongation values are lower than the permanent-mold values is not considered significant.

It must be remembered that alloy X357 was developed to obtain high yield strengths for applications where this value is of prime importance. If ductility is of primary importance alloy A356 is recommended. At any rate, since structural castings should be designed to the yield point of the alloy, it is difficult

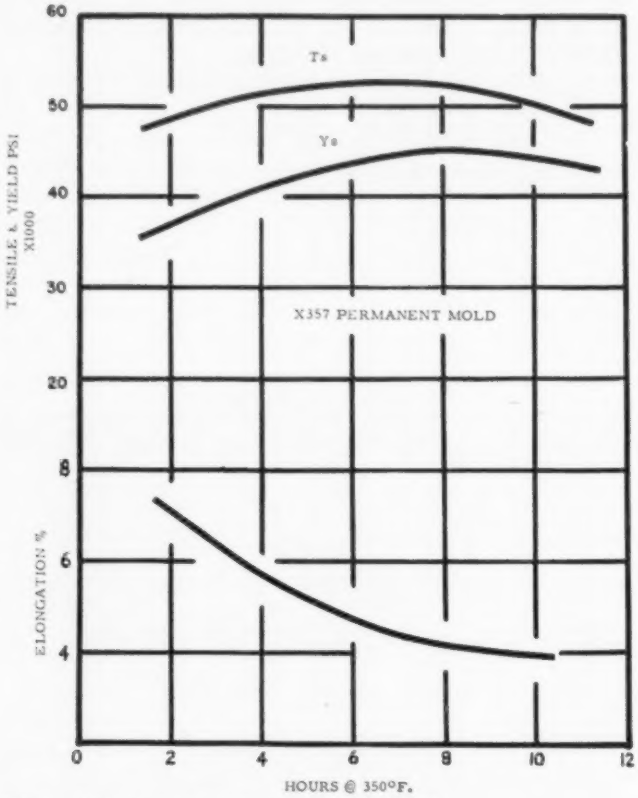

Fig. 2—Aging curves, permanent mold, X357.

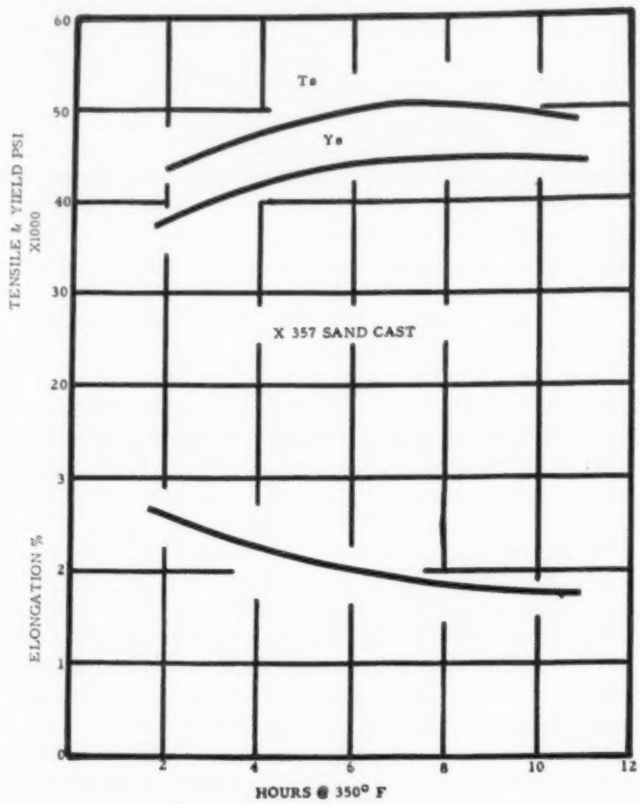

Fig. 3—Aging curves, sand cast, X357.

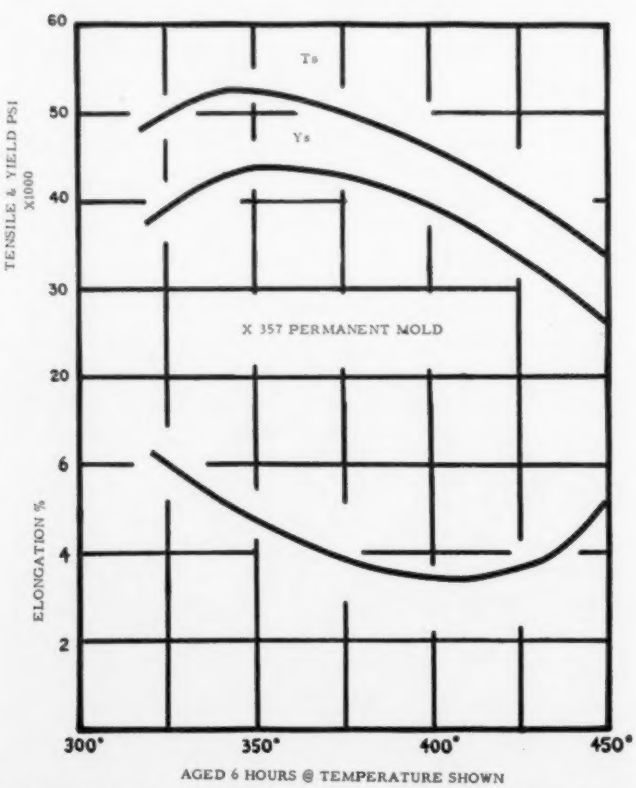

Fig. 4—Aging curves X357, permanent mold, aged 6 hr at temp. shown.

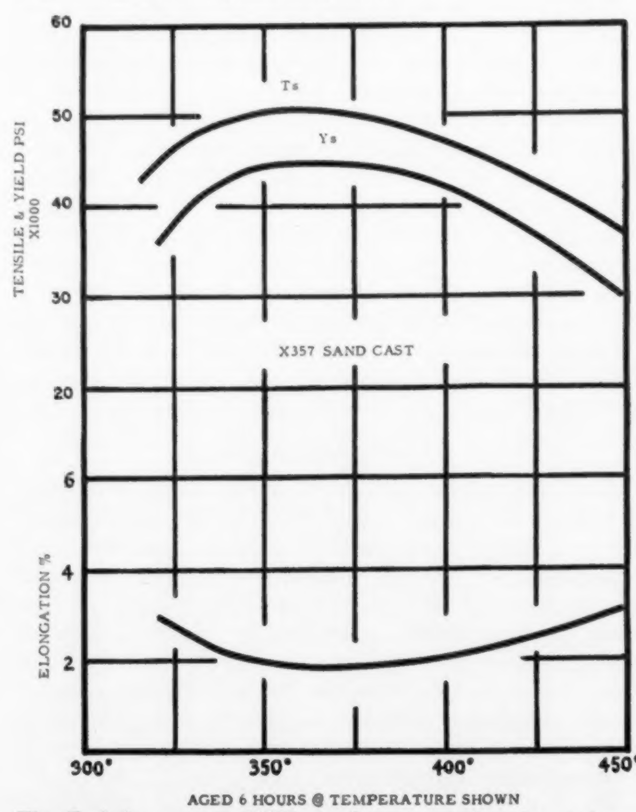

Fig. 5—Aging curves X357, sand cast, aged 6 hr at temp. shown.

TABLE 2 – AVERAGE BRINELL HARDNESS

Aged 6 Hr at Temp. F Shown	Sand Cast	Permanent Mold
320	75	85
350	90	100
400	70	85
450	60	70

TABLE 3 – AVERAGE PROPERTIES WHEN AGED 6 HR AT 350 F

Tensile Strength, psi	Tensile Yield Strength* psi	Elongation Per Cent in 2 in.	Remarks
52,000	43,000	5.0	Perm. Mold
50,000	43,000	2.0	Sand Cast

*Offset = 0.2 per cent

TABLE 4 – SUGGESTED AGING CYCLE FOR SAND CAST AND PERMANENT MOLD

Temper	Time, Hr	Temp., F
T6	6	350

to say what elongation value is sufficient and what value is not.

The average Brinell hardness values for alloy X357 are shown in Table 2 for different temperatures. The aging time in each case was six hr. The high values obtained at 350 F (177 C) are an indication that the alloy will exhibit excellent machinability. The average mechanical properties as indicated by the aging curves in Figs. 2 and 3 are shown in Table 3.

A suggested aging cycle for the T6 temper is shown in Table 4. It is assumed this aging cycle will vary depending on the type of heat treating equipment available.

CONCLUSION

High purity alloy X357 when heat treated exhibits superior tensile and yield strengths with good ductility. The alloy should find wide acceptance for applications involving highly stressed parts where high yield strength is a prime concern. The foundry characteristics of the alloy are excellent and no unusual melting or casting techniques are required to develop its full potential strength.

The alloy also exhibits excellent machinability as indicated by its high hardness values. Dimensional stability and corrosion resistance are also excellent.

The high strength values of X357 are developed by solution heat treatment and artificial aging. Furnace equipment designed to maintain temperatures within a limit of plus or minus 10 degrees is entirely suitable.

No attempt was made in this investigation to employ a room temperature interval between the quenching and aging cycle. However, additional ductility can be obtained, with some loss in yield strength, by employing a 24 hr holding period after the solution heat treatment and quenching cycle.[4]

It is apparent that aging temperatures higher than those usually encountered in the aging of aluminum-silicon-magnesium alloys are necessary to develop higher yield points in alloy X357.

There is no indication that mechanical properties decrease in value by the use of clean, uncontaminated returned foundry scrap in alloy X357 furnace charges.

ACKNOWLEDGMENT

The author wishes to express his appreciation to the Kaiser Aluminum and Chemical Corp. works at Chalmette, Louisiana; Newark, Ohio; and Trentwood, Washington; for their cooperation in developing this work.

Special appreciation is due to the following companies whose contributing efforts made this investigation possible. R. H. Osbrink Manufacturing Co., Los Angeles, Eck Foundries, Inc., Manitowoc, Wis., H & S Metal Products Co., Los Angeles, Oberdorfer Foundries, Inc., Syracuse, N. Y., Rayson Casting and Manufacturing Co., Gardena, Calif., and American Light Alloys, Little Falls, N. J.

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STUDY OF HIGH TEMPERATURE PROPERTIES OF SHELL MOLDS

Report of Sand Division Committee 8-N on Shell Molding Materials

Prepared By

R. A. Rabe*

ABSTRACT

A large percentage of the shell-mold casting scrap is due to shell cracking and shell expansion defects. This report covers work performed in cooperation with the AFS Shell Molding Materials Testing Committee (8-N) in order to determine the causes of such casting defects when various sand and resin mixes were used. Hot expansion and tensile strength tests of the shell mixes were performed in the laboratory in an attempt to correlate these tests with the expansion defects found in test pattern castings.

CONCLUSIONS AND RECOMMENDATIONS

The shells made with bank sand had less severe cracking than those made with an angular grain silica sand or a round grain silica sand. Test specimens made with the bank sand mixes also had lower hot expansion in the laboratory tests. All shell cracking took place in the first 15 to 60 sec after pouring.

The shells made with 6 per cent resin, dry mix had less severe cracking and less expansion than the shells made with a 4 per cent resin, cold-coated mix, for a given shell thickness.

The plate defect on the cope side of the test casting was entirely eliminated by reducing the gate area from 1.125 in.^{2} to 0.750 in.^{2}.

Castings made in silica sand (round or angular grain) shells had smoother surface finish than those made in bank sand shells.

Castings made in bank sand shells had fewer surface defects due to mold expansion than castings made in silica sand shells.

Because shell molds made with bank sand, containing up to 1 per cent clay, exhibited less cracking as compared to shells made with washed silica sands, bank sand is recommended where mold cracking is a problem.

TEST PROCEDURE

Pattern

The shell mold test pattern, shown in Fig. 1, was designed to promote casting defects. It is semi-circular in shape, 8 in. in diameter and 1 in. thick. The sprue is 4 in. high and 2.50 in. in diameter at the base. The risers are 2.75 in. in diameter. The area of one gate was 0.5625 in.^{2} This was reduced to 0.375 in.^{2} after the shells of cold coated Wedron sand and bank sand were made in order to eliminate the plate defect on the castings.

Sands

Three sands were selected for the shell mold mixes because they were representative of commercially available materials that are being widely used for shell molding. Figure 2 shows the sands at 15 diameters. Figure 3 shows the screen distribution of the sands. All three of the sands were sampled by taking specimens with a sand sampling tube from eight bags of sand.

Resins

The cold coated resin listed in the data as resin "A" is a powdered resin that has been used successfully for cold coating for several years.

The dry mix resin was also a powder. This material also has been used commercially for some time. It is listed as resin "G" in the data.

Mixing Procedure

All sand mixes were made in a No. 30 A speedmuller. The cold coated mixes were made in 100-lb batches; the dry mixes in 200-lb batches. The formulation and cycles are listed in Tables A, B and J in the Appendix.

Shell Making

All shells were made on a dump-type machine. Investment and cure were controlled by timers on the machine. The pattern was heated to 450 F and the temperature was checked before every shell was made. Variations in the shell weight with any one mix and investment time are due to the variations in the amount of sand in the dump box. Five shells were made at each investment time.

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Fig. 1—Shell mold test pattern designed to promote casting defects.

Shell Bonding

All shells were glued with a powdered resin in a shell process bonding fixture. Data were not taken on shells that came apart at the parting line due to improper gluing. When a shell separated at the parting during pouring, another was made to replace it.

Pouring

The shells were set either in trays or on the floor in 2 or 3 in. of dry sand. Green sand was packed around the sprues. No sand was placed on the copes of the shells. Pouring was done from hand ladles, with the spout placed as close to the sprue as possible. Metal temperatures were taken with an optical pyrometer while each shell was poured.

Metal Poured

Iron of the following analysis C 3.10-3.40, Mn 0.55-0.75, P 0.20 max., S 0.20 max., Si 2.15-2.35, Ni 0.07-0.15, and Cr 0.15-0.25 was melted in a 50-lb indirect arc furnace. Minimum tensile strength of this iron is 30,000 psi.

Fig. 2—Screen distribution of sands used for the test.

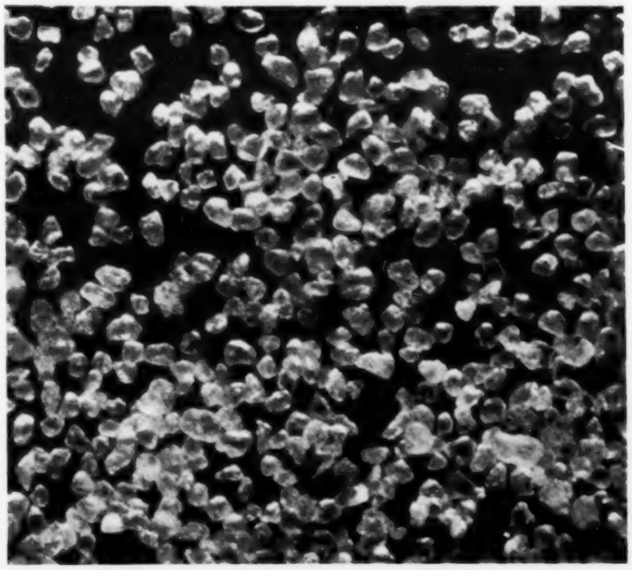


Fig. 2a—Wedron No. 8 silica sand, 109 AFS fineness, 3 screen. 15X.

Observations

The following data were recorded during the tests:

1. Shell thickness was measured in two places on a flat portion of the shell mold.
2. All shell molds were weighed and numbered after they were glued.
3. Notations were made on shell cracking that occurred during pouring of the molds.
4. All castings were numbered after the gates had been removed.
5. After a light sand blast the castings were checked dimensionally for diameter and thickness, and visually for defects.

Figure 4 shows the method of measuring cope and drag swell. The casting was levelled on the screws so that the dial indicator had a zero reading at the two corners and the mid-point of the circumference before the center reading was taken.

The casting diameter was measured on the cope side with vernier calipers.

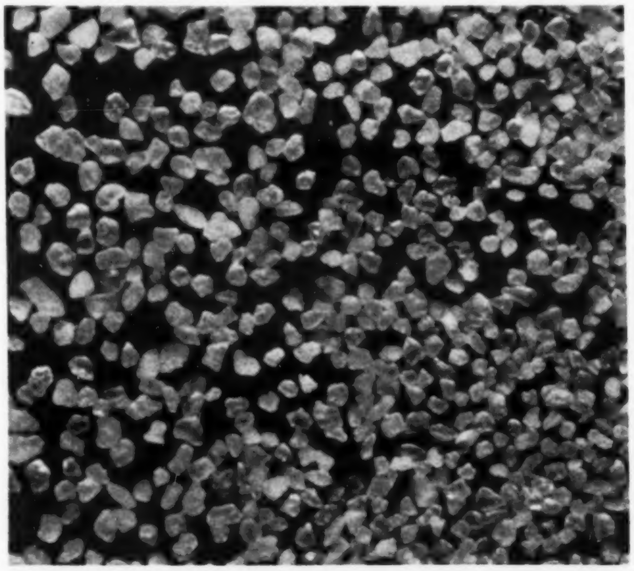


Fig. 2b—Vassar bank sand, 112 AFS fineness, 0.9 per cent clay, 3 screen. 15X.

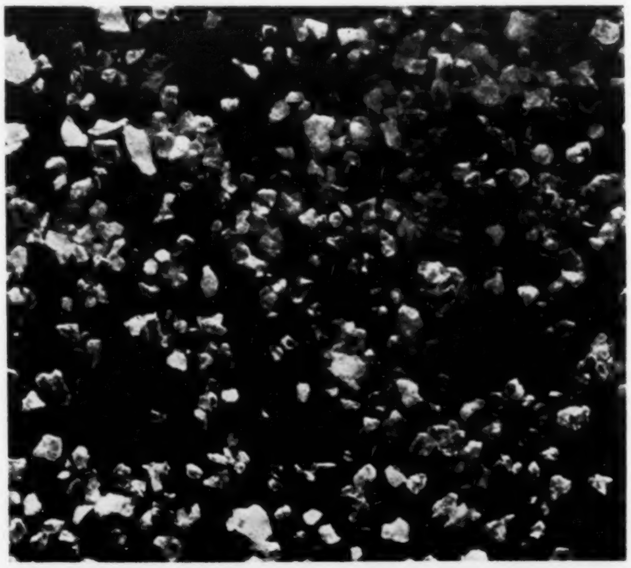


Fig. 2c — Penn glass sand, 117 AFS fineness, 5 screen. 15X.

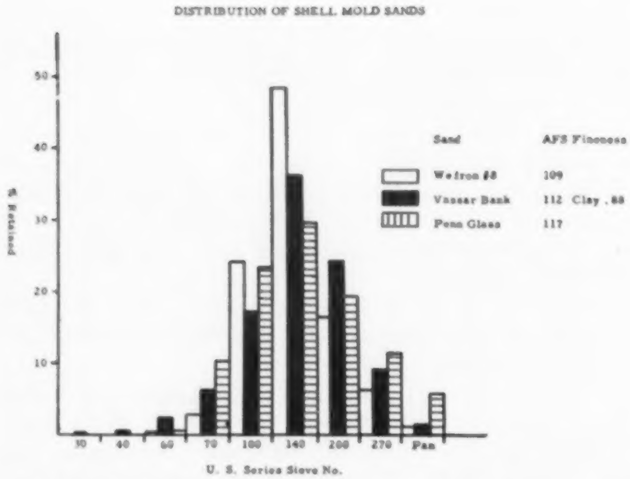


Fig. 3–Screen distribution of the three sands used for the test.

TABLE 1 – STRENGTHS OF SHELL MIXES

	Cold Coated Mix 4% Resin "A"			Dry Mix 6% Resin "G"		
Sand	Wedron	Bank	Penn Glass	Wedron	Bank	Penn Glass
Screens	3	3	5	3	3	5
Fineness	109	112	117	109	112	117
% Clay	...	0.88	...	...	0.88	...
T. S. in psi*	757	334	412	496	491	472
Weight of Specimen	26.5g	25.5g	24.7g	22.0g	22.3g	19.6g
Loss on Combustion	3.46%	3.91%	4.00%	4.41%	5.90%	5.79%
T. S. in psi/ 1% Resin	219	85.5	103	112.5	83.3	81.7

*AFS tentative standard procedure.

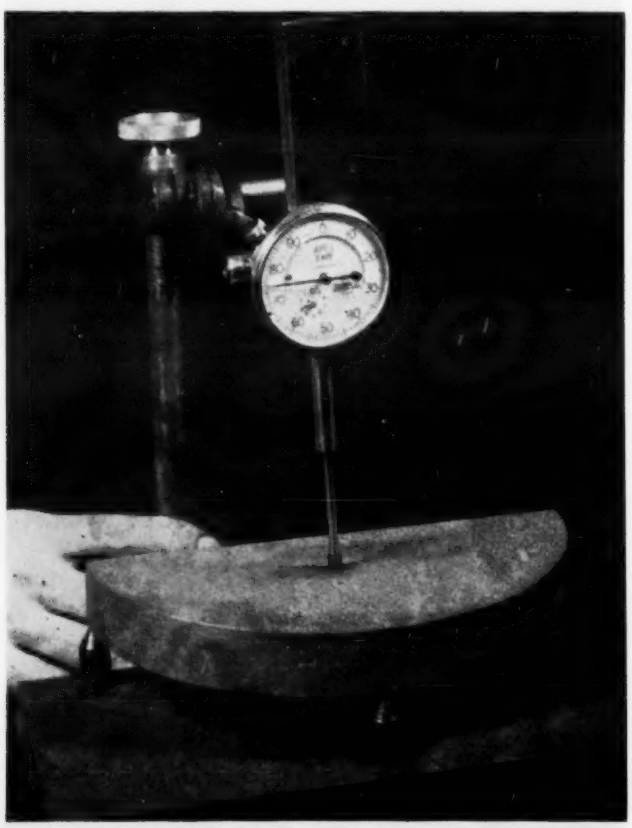


Fig. 4–The method used for measuring cope and drag swell on the test casting.

Shell Tensile Strength

Tensile strengths of the shell mixes were determined according to the AFS tentative standard procedure. The pattern temperature was 400 F and the cure cycle was three min in a 500 F oven.

High Temperature Tests

A specimen tube 1.50 in. in diameter and 2.125 in. long was first heated to 450 F. It was removed from the oven. Then the shell mix was dumped into the hot tube by quickly inverting a 2-in. pipe, 6 in. long, filled with shell mix. The excess mix was scraped from the top of the specimen tube and the tube and specimen were placed in a 500 F oven for five min. The shell specimen was removed from the tube and after cooling was ground to the 2-in. length and placed in a desicator.

The free expansion of the shell specimen was measured at 2000 F with an expansion micrometer in a thermolab.

RESULTS

From the first, it should be realized that the shell-mold test pattern used for this work was designed to promote casting defects. The casting cavity was purposely placed entirely in the cope. The casting was over-risered for the 35,000 lb tensile iron that was poured. It was known that many shell mold foundries are producing perfect castings with shell mixes incorporating the same sands, resins and perhaps the same mixes tested in this report.

Dry Shell Mixes

All the shells made with dry mixes had the reduced gate area on the pattern. The strengths of the dry shell mixes and the cold coated mixes are shown in Table 1.

Dry mixes take at least 30 per cent more investment time for a given shell thickness. This is shown in the graph in Fig. 6.

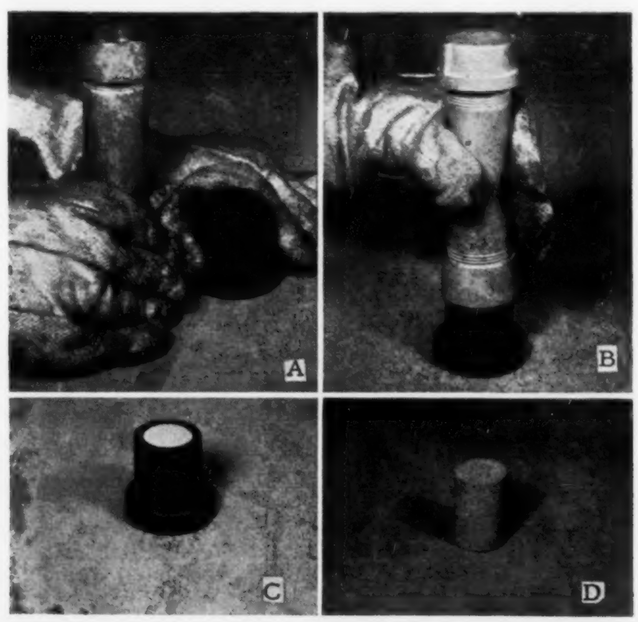


Fig. 5–(A-D)–Sequence of method of preparing shell specimens for high temperature tests.

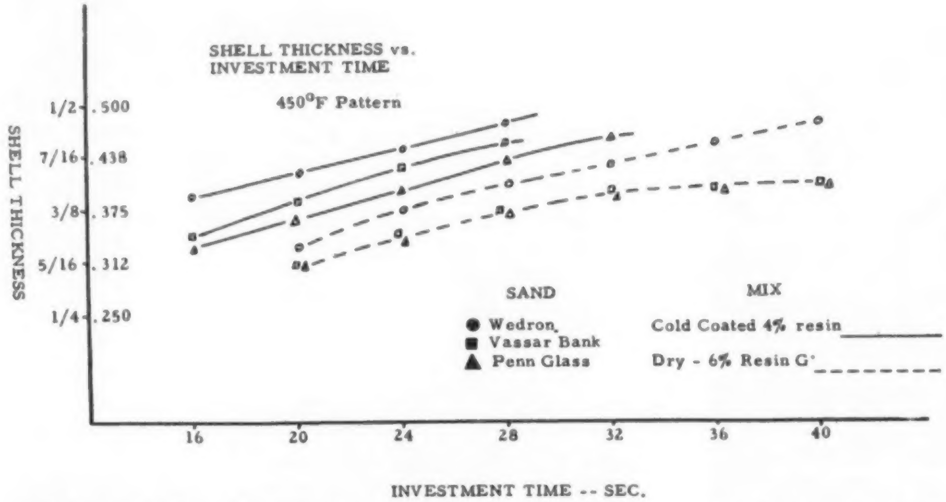


Fig. 6—Graph showing that dry mixes take at least 30 per cent more investment time for a given shell thickness.

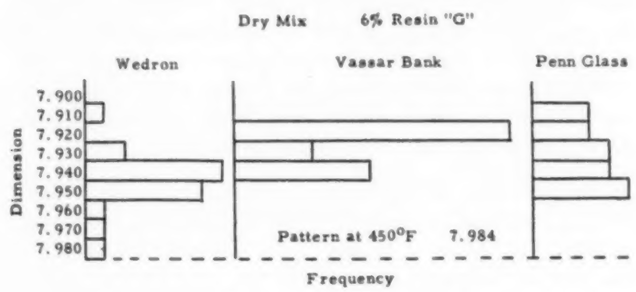
The use of these dry mixes will then slow the shell machine cycle for investment and curing. This loss in production may be partially offset by reduced casting scrap due to molds cracking.

Measurements of Casting Diameters

The bar chart (Fig. 7) is a plot of the casting diameter measurements and their frequency of occurrence. It can be seen from the frequency distribution that more than 20 or 25 castings should be checked to give good statistical data. The charts do show that linear dimensions can be held uniformly with various types of sand and resin mixes when shell expansion is restricted by the shell configuration.

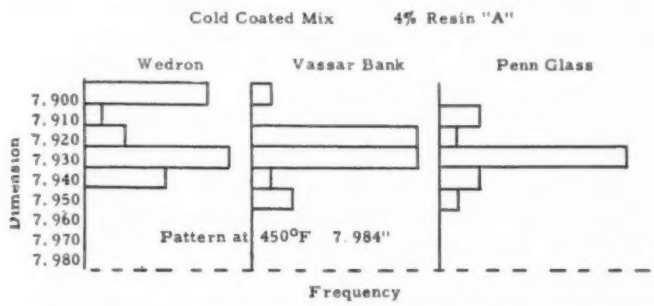
Measurements of Cope Swell

A different trend is noted in the measurements of cope swell Fig. 8. Here the castings made in dry-mix



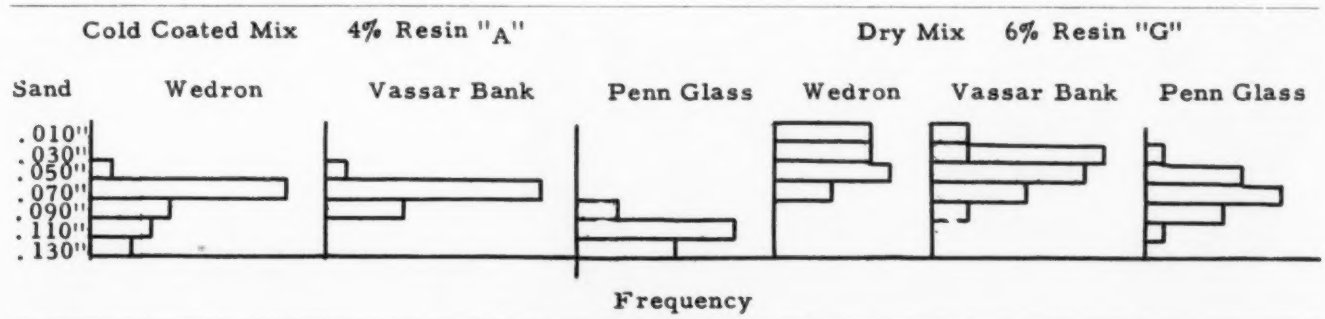
	Frequency		
	Wedron	Vassar Bank	Penn Glass
No. of shells poured	25	25	25
% Scrap due to Runout	24	0	24
Shell thickness, in.	0.387-0.468	0.337-0.415	0.344-0.406

Fig. 7a—Measurements of casting diameter, dry mix.



	Frequency		
	Wedron	Vasar Bank	Penn-Glass
No. of shells poured	20	20	23
% Scrap due to Runout	0	0	34.5
Shell thickness, in.	0.390-0.484	0.359-0.451	0.322-0.453

Fig. 7b—Measurements of casting diameter, cold-coated mix.



	Cold Coated Mix, 4% Resin "A"			Dry Mix, 6% Resin "G"		
	Wedron	Vassar Bank	Penn Glass	Wedron	Vassar Bank	Penn-Glass
No. of shells poured	20	20	23	25	0.25	0.25
% Scrap due to cope segment lifting	0	20	13	20	0	16

Fig. 8—Measurements of casting swell on cope side.

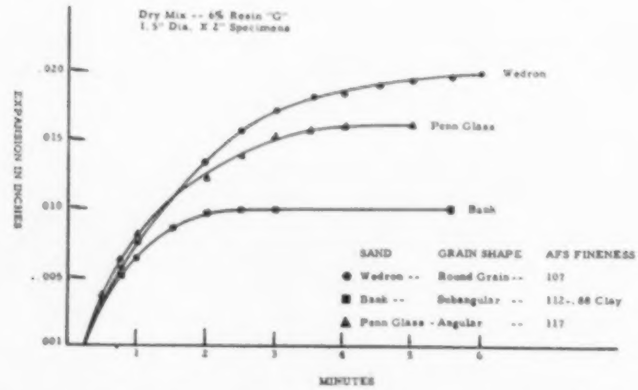


Fig. 9a—Graph showing free expansion of shell specimens at 2000 F, dry mix.

shell molds had (with a lower average shell thickness) about 0.040 in. less swell than the casting made in the cold coated mix molds. The cope swell was caused by shell expansion due to metal pressure and heat.

High Temperature Shell Expansion

The curves in Fig. 9a and 9b show the expansion of shell specimens at 2000 F. The specimens made with the dry shell mixes had the least expansion. The shells with these mixes had the least cracking, for a given shell thickness, in the foundry tests. The shells using bank sand had less expansion in the laboratory tests and less cracking in the foundry tests than shells using silica sand.

Casting Defects

Test data of the dry resin mixes gives the complete listing of the shell and casting defects. Shell cracking, where the symbol (*) is used in Tables D to O of the Appendix to denote that the cope segment lifted, was due to rapid burnout and failure of the shell mold and usually occurred with only the thinner shells.

Most of the pitting in these castings is thought to be due to resin segregation. No dust suppressant was used in any of the dry mixes, and resin segregation was apparent from the mottled appearance of the cured shells.

Shell thickness with the angular and bank sands was approaching the maximum obtainable with the 450 F pattern temperature, and the 6 per cent of resin "G". The shells made at the 36-sec investment and 40-sec investment were of very uneven thickness.

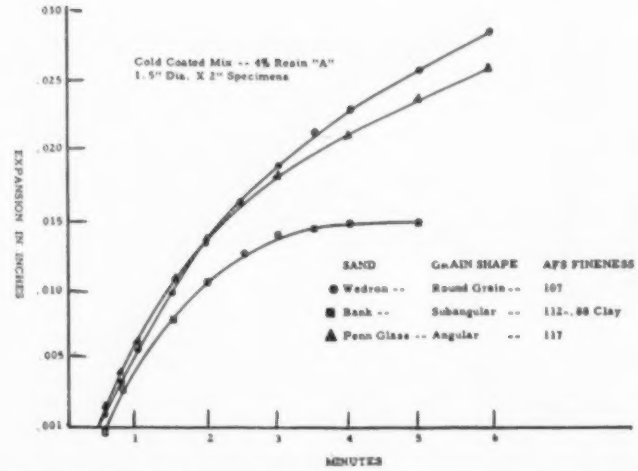


Fig. 9b—Graph showing free expansion of shell specimens at 2000 F, cold-coated mix.

Cold Coated Shell Mixes

The coating of sands with liquid or dry phenolic resins, both by the "hot" and "cold" processes, has been gaining in favor with shell foundries during the past three years. The cold-coated process was used in these tests because the equipment in the Process Development foundry was not designed for hot coating. Moreover, shells made with these mixes had produced good castings on semi-production runs.

The principal advantages of the coated mixes over the dry mixes are: 1) Reduction of dust and resin segregation, 2) Higher strength shells with lower resin content, 3) Increased shell density, 4) Shorter investment time for a given shell thickness, and 5) Uniform shell thickness over all areas of the pattern.

The cold-coated mix using the round grain Wedron sand had almost twice the tensile strength per lb of resin as the dry mix (Table 1). Coatings of the resin had less effect on the tensile strengths of the bank and angular sand mixes due to their larger grain surface areas.

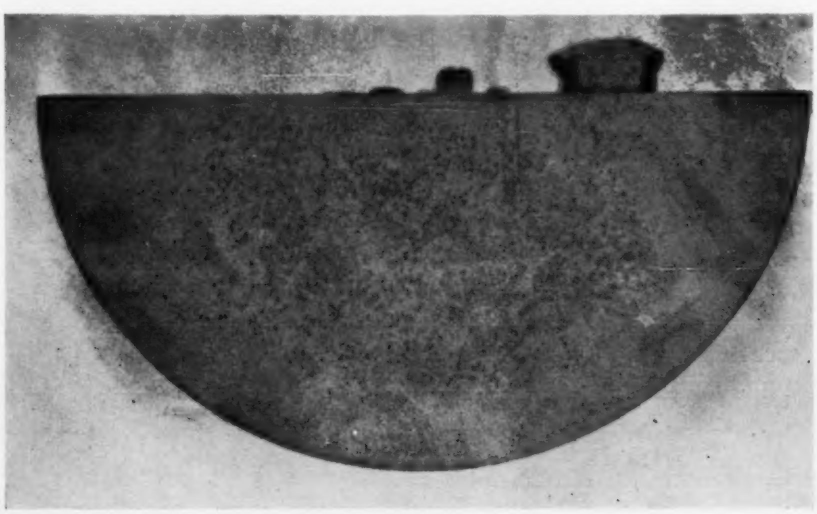


Fig. 10—Test casting showing plate defect eliminated by reducing gate.

Plate Defect

The shells of the Wedron and bank sand mixes were all made on the pattern with a gate area of 1.125 in.^{2}. Almost all the castings from these shells had the plate defect (Fig. 10). This is caused by metal rapidly filling the mold and forming a thin metal skin on the cope surface; then when the shell expands away from the metal, the ferrostatic pressure forces the molten metal through the thin skin. After the gate area on the pattern was reduced to 0.750 in.^{2} this defect was eliminated.

Rattail Defect

The rattail defect was most common with the castings poured in shell made with Wedron or Penn Glass silica sands. It was more severe on the castings made in thinner shells (Fig. 11).

Fig. 11—Edge view of test casting showing rattail defect on radius which was reduced by use of bank sand.

APPENDIX

Section 1—Test Data—Dry Mixes

TABLE A – PROCEDURE FOR DRY MIXING

Muller:	No. 30 Speedmuller	
Cycle:	Add sand and resin, mix 3 min.	
	Discharge and screen through 1/16-in. mesh.	
Mix:	Sand	94 lb.
	Resin "G"	6 lb.
Sand:	W – Wedron No. 8	
	B – Vassar Bank	
	P – Penn Glass LR	

TABLE B – SIEVE ANAYLSES

Sieve No.	Sand % Retained W	B	P
6			
12			
20			
30		0.48	
40		1.02	
50	0.06	3.14	0.92
70	0.64	8.28	10.22
100	22.56	21.12	23.32
140	52.70	32.76	29.70
200	15.74	20.14	19.02
270	5.90	9.28	11.20
Pan	2.16	3.96	5.52
Clay	....	0.90	....
Fineness No.	109	112	117

TABLE C – SHELL TENSILE STRENGTH – DRY MIX – 6 PER CENT RESIN "G"

At General Electric Laboratories			
Strike Off*	Wedron	Bank	P.G. "LR"
Tensile Strength, psi	685	466	409
Wt. 6 specimens – gms.	132.2	134	117.5
Blown**			
Tensile Strength, psi	504	425	386
Wt. 6 specimens – gms.	141	139	124.7
At Process Development Section Laboratory			
Strike Off*			
Tensile Strength, psi	496	491	472

*8-N procedure – 400 F pattern, bake 3 min. in 500 F oven.
**Blown at 30 psi, 450 F pattern, bake 2 min. in 700 F oven.

Test Results—Dry Mix

TABLE D – 20 SEC INVESTMENT, 42 SEC CURE – 450F PATTERN TEMP., 6 PER CENT RESIN "G"

Sand	Shell Weight lb	oz	Shell Thickness, in.	Pour Temp, F	Shell Cracking
W	12	2	11/32	2550	*
W	12		11/32	2560	*
W	11	9	5/16	2560	**
W	11	7	5/16	2510	*
W	11	5	5/16	2510	*
B	10	13	5/16	2520	** *
B	10	13	5/16	2520	*
B	10	13	5/16	2530	*
B	10	9	5/16	2560	*
B	10	1	5/16	2530	*
P	11	2	5/16	2560	*
P	10	14	5/16	2560	**
P	10	10	5/16	2550	*
P	10	9	5/16	2550	*
P	10		5/16	2540	*

All shells cracked at sprue or scope segment lifted. No good castings.
*Cope segments lifted.
**Sprue cracked

TABLE E – 24 SEC INVESTMENT, 42 SEC CURE – 450F PATTERN TEMP., 6 PER CENT RESIN "G"

Sand	Shell Weight lb	oz	Shell Thickness, in.	Pour Temp, F	Shell Cracking	Dia. A-C, in.	Cope Swell, in.	Drag Swell, in.	Casting Defects
W	13	10	13/32	2560	*				Run out.
W	13	8	13/32	2590	*				Run out.
W	13	6	3/8	2550	*				Run out.
W	13	6	3/8	2575	*				Run out.
W	13	3	3/8	2570	**	7.968	0.020	0.085	Fair surface finish, 0.030-in. fin between gates, slight rattail in cope, burn-in on radius.
B	12	6	11/32	2540		7.936	0.093	0.106	Cope raised, fin at parting line, slight burn-in all over.
B	11	11	11/32	2500		7.928	0.031	0.152	Slight pitting on cope, fin on diameter, rattail on drag.
B	11	7	11/32	2540	**	7.924	0.030	0.070	Good surface, slight misrun around top edge, slight fin at parting.
B	11	1	11/32	2560	**	7.936	0.042	0.074	Fair surface, fin at parting, slight pitting on cope, rattail on radius.
B	10	6	5/16	2510	**	7.920	0.047	0.112	Good surface, fin on diameter at parting.
P	10	12	11/32	2500	*				Run out.
P	10	14	11/32	2560	**				Run out.
P	10	11	11/32	2500	*				Run out.
P	10	9	11/32	2560	**				Run out.
P	10	4	11/32	2550	*				Run out.

*Cope segment lifted.
**Sprue cracked.

TABLE F – 28 SEC INVESTMENT, 44 SEC CURE, – 450F PATTERN TEMP., 6 PER CENT RESIN "G"

Sand	Shell Weight lb	oz	Shell Thickness, in.	Pour Temp, F	Shell Cracking	Dia. A-C, in.	Cope Swell, in.	Drag Swell, in.	Casting Defects
W	14	5	13/32	2560		7.948	0.015	0.076	Pitting on cope, slight burn-in, rattail on radius.
W	14	5	13/32	2530		7.975	0.007	0.024	Pitting on cope, slight burn-in, slight rattail on radius.
W	14	2	13/32	2550	**	7.950	0.007	0.073	Pitting on cope, slight burn-in on radius and drag, slight rattail on radius.
W	13	14	25/64	2540	**				Run out.
W	13	5	25/64	2560	*				Run out.
B	13	8	3/8	2530		7.920	0.025	0.074	Rough and pitted on cope, rattail on radius.
B	13	6	3/8	2520		7.917	0.018	0.070	Rough on cope, slight wash at gate in drag.
B	13	5	3/8	2540		7.926	0.061	0.125	Rough on cope, slight pitting on cope, fin between gates.
B	12	15	3/8	2530		7.932	0.095	0.091	Rough and pitted on cope, cope lifted, rattail on radius, fin at parting.
B	12	11	3/8	2540		7.933	0.019	0.104	Rough and pitted on cope, rattail on radius, fin at parting along diameter.
P	14	9†	7/16	2500		7.916	0.098	0.070	Slight pitting on cope, drag finish good.
P	14	5†	3/8	2500		7.908	0.064	0.055	Slight pitting on cope, drag finish good.
P	14	1†	3/8	2520		7.926	0.076	0.066	Slight roughness on cope, slight porosity in drag, rattail on radius.
P	12	6	3/8	2560		7.954	0.069	0.067	Cope raised, good drag finish, fin at parting line between gates.
P	12	11	3/8	2540	*				Run out.

†Shell overweight due to louvers leaking.
*Cope segments lifted.
**Sprue cracked.

TABLE G – 32 SEC INVESTMENT, 44 SEC CURE, – 450F PATTERN TEMP., 6 PER CENT RESIN "G"

Sand	Shell Weight lb	oz	Shell Thickness, in.	Pour Temp, F	Shell Cracking	Dia. A-C, in.	Cope Swell, in.	Drag Swell, in.	Casting Defects
W	15	13	15/32	2545		7.912	0.060	0.064	Slight pitting on cope, fin at parting, rattail on drag.
W	15	9	7/16	2540	** sl	7.940	0.032	0.072	Cope pitted and not all filled out due to run out. Slight roughness on drag, slight fin at parting.
W	15	7	7/16	2540	** sl	7.944	0.035	0.084	Pitting on cope and drag, rattail on radius.
W	15	7	7/16	2540	** sl	7.955	0.030	0.085	Slight pitting on cope, rattail on radius, slight fin at parting.
W	14	15	7/16	2535	** sl	7.950	0.017	0.073	Rough and pitted on cope, cope lifted, rattail on drag.
B	14	7	7/16	2600	** sl	7.924	0.062	0.070	Slight roughness all over, slight fin at parting.
B	14	5	7/16	2600	** sl	7.923	0.057	0.072	Slight roughness on cope, fin at parting along dia.
B	13	15	13/32	2560		7.924	0.036	0.059	Good finish, slight rattail on radius, slight fin at parting.
B	13	14	13/32	2500	** sl	7.921	0.045	0.060	Slight pitting on cope, cope rough due to run out, slight fin at parting.
B	13	13	13/32	2500		7.920	0.030	0.047	Slight pitting and roughness on cope, drag surface good.
P	13	6	13/32	2520		7.930	0.059	0.051	Slight pitting on cope, drag surface good, rattail all around radius.
P	12	15	13/32	2500		7.924	0.099	0.065	Slight pitting on cope, drag surface good, slight rattail all around radius.
P	12	9	13/32	2500	** sl	7.945	0.033	0.053	Slight pitting on cope, heavy rattail on radius, slight rattail on drag.
P	11	14	3/8	2500	** sl	7.946	0.030	0.092	Slight roughness on cope and drag, slight rattail on radius, fin between gates at parting.
P	11	9	3/8	2540		7.907		0.076	Cope raised, drag surface good, fin between gates at parting.

**Sprue cracked.

TABLE H – 36 SEC INVESTMENT, 44 SEC CURE, – 450F PATTERN TEMP., 6 PER CENT RESIN "G"

Sand	Shell Weight lb	oz	Shell Thickness, in.	Pour Temp, F	Shell Cracking	Dia. A-C, in.	Cope Swell, in.	Drag Swell, in.	Casting Defects
W	14	10	7/16	2500	**	7.946	0.025	0.043	Pitting on cope, good drag surface, slight rattail on radius, fin at parting.
W	14	2	7/16	2500	**	7.950	0.028	0.048	One pit in cope, good drag surface, casting partially hollow due to runout above one gate, rattail on radius.
W	14		7/16	2450		7.942	0.062	0.066	Pit on cope, excellent drag surface.
W	13	14	13/32	2450		7.946	0.075	0.098	Pitting on cope, good drag surface, rattail on radius.
W	13	14	13/32	2450		7.943	0.046	0.098	Pit on cope, good drag surface, slight rattail on radius.
B	15	3	7/16	2520	**	7.921	0.044	0.037	Excellent surface on cope and drag.
B	14	14	7/16	2540		7.917	0.054	0.047	Slight pitting on cope, good drag surface, slight rattail on radius, fin at parting (0.010-in.).
B	14	10	13/32	2520	**	7.919	0.053	0.051	One pit in cope, excellent drag surface, fin between gates at parting.
B	14	3	13/32	2540	**	7.924	0.025	0.067	Slight pitting on cope, good drag surface, slight rattail on radius, fin around parting (0.020-in.).
B	13	10	13/32	2490		7.916	0.035	0.042	Very slight pitting on cope, dirt in drag, slight rattail on radius.
P	14	4	7/16	2520		7.932	0.099	0.061	Slight pitting on cope, excellent drag surface, fin on radius.
P	13	12	7/16	2480	**	7.935	0.057	0.060	Slight pitting on cope, fair drag surface, slight roughness on radius.
P	13	13	7/16	2520		7.911	0.106	0.057	One slight pit on cope, excellent drag surface, slight rattail on radius, fin at parting along dia.
P	12	13	7/16	2480	**	7.935	0.064	0.062	Slight roughness on cope, good drag surface.
P	12	9	13/32	2510		7.932	0.078	0.065	Excellent surface cope and drag, fin on radius where shell cracked.

**Sprue cracked.

TABLE I – 40 SEC INVESTMENT, 44 SEC CURE, – 450F PATTERN TEMP., 6 PER CENT RESIN "G"

Sand	Shell Weight lb	Shell Weight oz	Shell Thickness, in.	Pour Temp, F	Shell Cracking	Dia. A-C, in.	Cope Swell, in.	Drag Swell, in.	Casting Defects
W	15	12	15/32	2450		7.932	0.053	0.055	Pitting in cope, drag surface good.
W	15	10	15/32	2450		7.925	0.050	0.055	Pitting in cope, drag surface good, slight rattail on radius.
W	15	6	15/32	2450		7.935	0.059	0.058	Pit in cope 1 in. square, slight rattail on radius, fair drag surface.
W	15	5	15/32	2450		7.936	0.070	0.055	Pitting in cope, good drag surface, runout above one gate.
W	15		15/32	2450		7.935	0.057	0.048	Slight pitting in cope, good drag surface.
B	13	15	7/16	2520	**	7.936	0.065	0.037	Very slight pit in cope, good drag surface.
B	13	10	13/32	2525	**	7.935	0.056	0.048	Excellent surface cope and drag.
B	13	9	13/32	2530	**	7.937	0.034	0.100	Good surface all over, fin in parting due to poor glue joint.
B	13	9	13/32	2530	**	7.935	0.062	0.045	Slight sticker on cope, excellent drag surface.
B	13	8	13/32	2530	**	7.937	0.040	0.059	Pitting in cope, slight pit in drag, slight rattail on radius.
P	13	1	13/32	2490		7.920	0.105	0.096	Very slight pit in cope, excellent drag surface, slight rattail on radius, fin at parting between gates.
P	13		13/32	2490	**	7.952	0.043	0.034	Slight pit in cope, slight roughness on drag, rattail on radius.
P	12	14	13/32	2500	**	7.940	0.088	0.081	Pit in cope, cope lifted around radius, good drag surface.
P	12	12	13/32	2500	** sl	7.946	0.028	0.080	Pitting in cope and drag, slight rattail on radius, slight fin at parting.
P	12	10	13/32	2500		7.944	0.107	0.087	Pitting on cope (1/3 of area).

**Sprue cracked.

Section 2–Test Data–Cold Coated Mixes

TABLE J – MIXING PROCEDURE FOR COLD COATING

Ingredient	Amount
Sand	96 lb.
Resin "A"	4 lb.
Alcohol	500 cc.
Water	133 cc.

Cycle in No. 30 A speedmuller.
Add sand and resin – mix 15 sec.
Add alcohol and water – mix 5 min.
Dump on floor and allow to cool. Screen through 1/8-in. mesh.

Test Results–Cold Coated Mix

TABLE K – 16 SEC INVESTMENT, 35 SEC CURE, 450 F PATTERN TEMP., 4 PER CENT RESIN "A"

Sand	Shell Weight lb	Shell Weight oz	Shell Thickness, in.	Pour Temp, F	Shell Cracking	Dia. A-C, in.	Cope Swell, in.	Drag Swell, in.	Casting Defects
B	13	1	22/64	2535		7.928	0.084	0.030	2/3 cope has plate defect.
B	13	10	22/64	2550	*	7.929		0.023	Rough plate on cope.
B	13	5	23/64	2545	*	7.926		0.013	Cope segment lifted.
B	13	12	24/64	2550		7.932	0.087	0.055	3/4 cope has plate defect, slight fin on drag, slight rattail on drag.
B	13	8	25/64	2550	*	7.953		0.020	Slight rattail on drag
W	14	15	25/64	2535		7.931	0.063	0.038	1/2 cope has plate detect.
W	15	1	24/64	2550		7.931	0.094	0.101	Slight plate on cope.
W	15		26/64	2545		7.920	0.085	0.039	1/2 cope has plate defect.
W	14	14	25/64	2550		7.930	0.068	0.028	1/3 cope has plate defect.
W	15		25/64	2550		7.929	0.070	0.025	1/2 cope has plate defect.
P	10	15	21/64	2520	*				Run out.
P	10	14	21/64	2530	*				Run out.
P	10	12	21/64	2520	**				Run out.
P	10	4	5/16	2530	*	7.925	0.126	0.262	Slight pitting in cope, burn-in on cope, drag swell, rattail on radius.
P	10	2	5/16	2525	**				Run out.

* Cope segment lifted.
** Sprue cracked.

TABLE L – 20 SEC INVESTMENT, 35 SEC CURE, 450 F TEMP., 4 PER CENT RESIN "A"

Sand	Shell Weight lb	Shell Weight oz	Shell Thickness, in.	Pour Temp, F	Shell Cracking	Dia. A-C, in.	Cope Swell, in.	Drag Swell, in.	Casting Defects
B	14	6	26/64			7.920	0.081	0.035	
P	14		25/64	2550	*	7.920		0.029	Cope segment lifted, slight rattail on drag.
B	14	7	26/64	2570		7.917	0.072	0.015	Slight roughness on cope, slight fin at parting line.
B	13	14	24/64	2585		7.919	0.086	0.052	Very slight plate on cope, slight fin at parting line.
B	14		24/64	2555		7.903	0.072	0.006	Very slight plate on cope.
W	15	7	25/64			7.893	0.092	0.038	
W	15	15	25/64	2550		7.894	0.127	0.036	Very slight plate on cope.
W	15	11	26/64	2570		7.896	0.137	0.053	Slight plate on cope.
W	15	10	26/64	2585		7.928	0.110	0.022	Slight plate on cope, rattail on cope.
W	15	13	25/64	2555		7.935	0.094	0.030	1/2 cope shows plate.
P	12	6	3/8	2530		7.928	0.129	0.131	Slight pitting on cope, slight rattail in radius, fin between gates.
P	11	14	3/8	2540	**				Run out.
P	11	12	11/32	2500		7.907	0.112	0.070	Slight burn-in on cope. Slight pitting in cope, rattail on radius.
P	11	12	11/32	2525		7.928	0.112	0.076	Slight pitting in cope, rattail on radius.
P	11	12	11/32	2500		7.933	0.132	0.121	Slight pitting in cope, heavy rattail on radius, fin between gates.

* Cope segment lifted.
** Sprue cracked.

TABLE M – 24 SEC INVESTMENT, 40 SEC CURE, 450 F PATTERN TEMP., 4 PER CENT RESIN "A"

Sand	Shell Weight lb	Shell Weight oz	Shell Thickness, in.	Pour Temp, F	Shell Cracking	Dia. A-C, in.	Cope Swell, in.	Drag Swell, in.	Casting Defects
B	15	14	29/64	2550		7.927	0.067	0.048	
B	15	13	28/64	2540		7.922	0.068	0.041	Slight plate on cope, slight fin at parting between gates.
B	15	9	27/64	2550		7.921	0.073	0.017	Slight roughness on drag, slight fin at parting between gates.
B	15	14	29/64	2615		7.921	0.066	0.031	Slight roughness on cope and drag, slight fin at parting line between gates.
B	15	11	28/64	2550		7.925	0.077	0.053	Slight roughness on cope and drag, slight fin.
W	17	4	29/64	2550		7.936	0.069	0.040	2/3 cope has plate, fin at parting.
W	17	2	29/64	2540		7.888	0.113	0.035	Slight plate on cope, fin at parting.
W	17	4	28/64	2550		7.884	0.110	0.050	Slight fin at parting between gates.
W	16	15	28/64	2615		7.944	0.078	0.062	Slight roughness on cope and drag, fin at parting between gates.
W	17	2	29/64	2555		7.946	0.075	0.053	1/3 cope has plate, fin between gates.
P	13	5	13/32	2500		7.928	0.105	0.099	Gas holes in cope, slight pitting, rattail on radius.
P	13	3	13/32	2500	**	7.942	0.125	0.083	Slight rattail on cope and radius, fin between gates.
P	13	3	13/32	2500	**				Run out.
P	13	2	13/32	2500	**				Run out.
P	12	12	13/32	2500	**				Run out.

** Sprue cracked.

TABLE N – 28 SEC INVESTMENT, 40 SEC CURE, 450 PATTERN TEMP., 4 PER CENT RESIN "A"

Sand	Shell Weight lb	Shell Weight oz	Shell Thickness, in.	Pour Temp, F	Shell Cracking	Dia. A-C, in.	Cope Swell, in.	Drag Swell, in.	Casting Defects
B	16	5	28/64	2645		7.922	0.063	0.021	Slight pitting on cope.
B	16	7	29/64	2550		7.930	0.059	0.026	
B	16	7	29/64	2530		7.934	0.064	0.022	
B	16	8	29/64	2540		7.945	0.063	0.010	Fin on cope and drag.
B	16	13	29/64	2530		7.943	0.061	0.020	Slight pitting on cope.
W	17	1	30/64	2645		7.922	0.056	0.046	1/3 cope has plate, slight plate on drag.
W	17	3	32/64	2550		7.928	0.066	0.028	
W	17	8	32/64	2530		7.900	0.068	0.036	
W	17	2	30/64	2540		7.931	0.062	0.027	Slight plate on cope.
W	16	14	30/64	2530		7.905	0.065	0.031	Slight pitting on cope.
P	14	6	7/16	2500		7.914	0.115	0.085	Very slight rattail on radius.
P	14	5	7/16	2500		7.927	0.081	0.055	Slight rattail on radius.
P	14	4	7/16	2510		7.929	0.116	0.098	Rattail on radius, fin between gates.
P	14	2	7/16	2500		7.928	0.119	0.090	Slight rattail on radius, slight fin between gates.
P	14	2	7/16	2500		7.917	0.110	0.077	Slight rattail on radius, slight fin between gates.

TABLE O – 32 SEC INVESTMENT, 40 SEC CURE, 450 F PATTERN TEMP., 4 PER CENT RESIN "A"

Sand	Shell Weight lb	Shell Weight oz	Shell Thickness, in.	Pour Temp, F	Shell Cracking	Dia. A-C, in.	Cope Swell, in.	Drag Swell, in.	Casting Defects
P	14	15	29/64	2530		7.951	0.106	0.096	Rattail on cope, drag, and radius, fin between gates.
P	14	11	29/64	2525	**	7.942	0.098	0.079	Heavy rattail on radius, fin between gates.
P	14	10	29/64	2520		7.931	0.110	0.095	Heavy rattail on radius, fin between gates.

** Sprue cracked.

CONSTRUCTION OF SHELL MOLD PATTERNS AND CORE BOXES

By

Wayne A. Wright*

In the past 10 years there have been many changes in the equipment and methods used to produce shell-molded castings and concurrent with these changes the thinking in terms of pattern equipment and core boxes has also been altered. Originally, it was thought that aluminum match plates would be adequate and result in low cost conversions from conventional molding methods.

While this is still being done to some extent the majority of the foundries have found that in order to maximize the quality of the shell casting and the life of the equipment, better material must be used and machined to closer tolerances. Selection of the material which best fits an individual job entails the use of many factors including: 1) initial cost, 2) number of pieces to be run, 3) accuracy required in the casting, 4) type of molding or core making machine to be used, and 5) design of the part itself.

The materials which we will consider here are all presently being used and are aluminum, bronze, iron, and steel. There are several modifications of each which to some extent changes their physical properties, but for the purpose of comparison the four basic materials are charted in Table 1.

On the basis of this chart if we had a casting which was to be high production, and had relatively thin high projections, to be run on a machine where the pattern temperature varied, and had to be held to very close tolerances, we would choose cast iron for the following reasons. Low maintainence cost and greater production life would be more important than initial cost. Coefficient of expansion being less results in greater accuracy despite the variance in pattern temperature and greater heat capacity produces a more uniform shell on high thin sections of the pattern. In evaluating the type of material to be used for a shell core box, the additional factor of weight must be considered where the box is to be hand operated.

Foundries which have been producing shell castings for any length of time have undoubtedly set standards for pattern and core box material already based on their experience or personal preference and as a result, a chart such as in Table 1 is more useful to those just starting to produce shell castings or those who contemplate getting into this field.

Design and construction of shell equipment once the material has been selected is at present almost impossible to standardize since in addition to the molding and core making machines on the market many foundries have equipment of their own design, each somewhat different and requiring special tooling. Despite this there are several primary steps to consider which should be helpful to designers. They are as follows:

Stabilize the material used to prevent growth and distortion.

Use like materials with the same coefficient of expansion in a given pattern or core box.

In using separate cope and drag patterns keep them as uniform in mass as possible so that they will expand a like amount at operating temperatures.

When high thin projections are required insert the cavities so that they extend all the way through the base plates giving uninterrupted continuity for conduction of heat from its source to these projections. The efficiency of this type of pattern will also be increased by the use of a material with high heat capacity.

Wherever possible, radius the external corners of the pattern cavities, gates, and runners to get a more uniform build-up of shell material in these areas (Fig. 1). In addition to improving the overall strength of the shell this will aid in reducing cracking caused by thermal shock.

TABLE 1 – COMPARISON OF FOUR BASIC MATERIALS USED*

	Initial Cost	Maintenance Cost	Life Expectancy	Thermal Conductivity	Coefficient of Expansion	Specific Heat
Aluminum	1	3	3	1	4	4
Brass or Bronze	2	2	2	3	3	1
Iron	4	1	1	4	1	3
Steel	3	1	1	2	2	2

*Lowest number denotes most desirable.

*Woodruff & Edwards, Inc., Elgin, Ill.

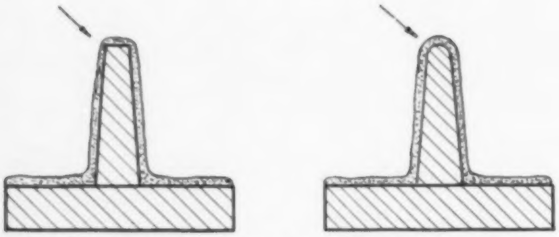


Fig. 1—left—Shell material does not build up on sharp corners. Right—Shell material builds up uniformly on radius.

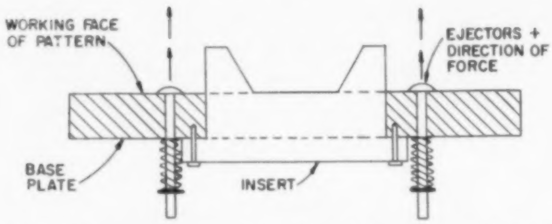


Fig. 2—Cavities which must be inserted should be put in from the back or non-working face of the base plate to help keep them from loosening due to the constant force of ejections.

Cavities which must be inserted should be put in from the back or non-working face of the base plate to help keep them from loosening due to the constant force of ejection (Fig. 2). This again will also aid in the conduction of heat.

Standardize component parts such as ejectors, base plates, sprues, locators, etc. This will permit interchangeability, lower the cost by reason of purchasing greater quantities of a given item, and simplify cost estimating for quotation purposes. In addition, availability of repair parts will minimize downtime due to damage or wear.

All parts of patterns and core boxes which are threaded should be coated with a protective material to prevent them from seizing.

As it is relatively difficult to estimate shrinkage in thousandths of in., multiple cavity, close tolerance patterns, and core boxes should be made in stages. Finish one cavity first, make the necessary changes after casting and then complete the balance of the cavities. Even on single cavity patterns it is always better to leave additional stock on critical areas until samples are made to establish an accurate shrink rule. These methods will both add to the overall pattern cost but will save many trips to the customer asking for dimensional changes or if that fails, it will save expensive trips to the patternmaker to have the patterns rebuilt.

The use of inserts is also more costly in some instances but is less expensive in case of damage or pattern shop error than if the entire pattern were machined as one integral unit.

Where shell cores are to be used in conjunction with shell molds it is helpful to design so that the core prints locate on the O.D. of the core. An example of this is in the setting of a ring core over a male print. Additional clearance must be used in setting a core at room temperature onto a mold at 500 degrees.

To obtain maximum tool life, at least 1/2-degree draft should be used on vertical surfaces. Shells can be ejected without the aid of draft, but the constant rubbing action of mold against pattern will result in excessive wear.

SUMMARY

The fabrication of parts by the shell-mold process is now an accepted and welcome addition to the many methods employed by the foundry industry to produce castings. In fact, it has been a useful tool in returning to the industry business previously lost to competitive methods of manufacture. It is the author's opinion that shell molding has by no means reached its ultimate growth, and that it will continue to consume a substantial portion of the total tonnage of the industry.

This being the case, it would seem that the industry as a whole should begin to think in terms of a general standardization of shell machines, patterns, core boxes, and auxiliary equipment similar to that found in regular molding processes. For instance, a shell customer today is at a terrific disadvantage in attempting to move his equipment from one foundry to another without paying a premium for converting to a different type of machine and while this is a temporary asset to the foundry which has the equipment it is most certainly a deterrent factor in a customer's future decisions on the designing or buying of shell-molded castings.

CONTENTS

Increasing Regions Aids Representation

■ Revision of the AFS Regional organization by the Board of Directors has increased the original five regions to seven, each headed by a Regional Vice-President, all of whom are members of the Board's Executive Committee.

Each Regional Vice-President will hold at least one regional administration meeting annually with fellow Directors, Chapter Chairmen and Vice-Chairmen.

Regional Administration Meetings

Region 4	Oct. 14	University of Michigan, Ann Arbor, Mich.
Region 2	Oct. 15	Royal Connaught Hotel, Hamilton, Ont.
Region 1	Oct. 16	Hotel Statler, Boston.
Region 5	Oct. 20	Hotel Astor, Milwaukee.
Region 6	Nov. 7	Peabody Hotel, Memphis, Tenn.
Region 3	Jan. 16	Hotel Statler, Cleveland.
Region 7	March 12	Huntington Hotel, Pasadena, Calif.

The revision gives more equal distribution of membership in chapter groups and regions, providing constant Director representation of every chapter group on the Board at all times.

Contacts with the Student Chapters and Chapters are made by all AFS Directors and AFS President L. H. Durdin and AFS Vice-President C. E. Nelson.

The seven regions with their chapters and contacts assignments:

Region No. 1

Regional Vice-President—Henry G. Stenberg.

Chapter Group A: *Brooklyn Polytechnic Institute* (Hochrein); *Connecticut* (Stenberg); *Massachusetts Institute of Technology* (Stenberg); *Metropolitan* (Hochrein); *New England* (Stenberg).

Chapter Group B: *Chesapeake* (Hochrein) and *Philadelphia* (Curry); *Piedmont* (Curry).

Region No. 2

Regional Vice-President—Roger W. Griswold.

Chapter Group C: *Central New York, Eastern New York, Rochester,* all contacts by Wm. D. Dunn.

Chapter Group D: *Eastern Canada* and *Ontario* (director to be appointed).

Chapter Group E: *Northwestern Pennsylvania, Pennsylvania State University, Pittsburgh, Western New York* (all contacts by Griswold).

Region No. 3

Regional Vice-President—Fred J. Pfarr.

Chapter Group F: *Northeastern Ohio* (Pfarr).

Chapter Group G: *Canton District* (Pfarr); *Central Ohio* (Rusk); *Ohio State University* (Rusk); *Toledo* (Rusk).

Region No. 4

Regional Vice-President—Charles E. Drury.

Chapter Group H: *Detroit* (Dietert); *Saginaw Valley* (Nelson); *University of Michigan* (Nelson).

Chapter Group I: *Central Michigan* (Boyd); *Michiana* (Drury); *Michigan State University* (Boyd): *Western Michigan* (Boyd).

Chapter Group J: *Central Indiana* (Drury); *Cincinnati District* (Deas).

Region No. 5

Regional Vice-President—Allen M. Slichter.

Chapter Group K: *Chicago* (Sanders, Phillips).

Chapter Group L: *University of Wisconsin; Wisconsin* (Slichter).

Chapter Group M: *Central Illinois* (Martens): *Northern Illinois & Southern Wisconsin* (Slichter); *Quad City* (Martens); *Twin City* (Patton); *University of Illinois* (Sanders).

Region No. 6

Regional Vice-President—Karl L. Landgrebe, Jr.

Chapter Group N: *Corn Belt* (Kammerer); *Mo-Kan* (Kammerer); *Timberline* (Dee); *St. Louis District* (Kammerer); *University of Missouri Schools of Mines & Metallurgy* (Kammerer).

Chapter Group O: *Birmingham District* (Durdin); *Mid-South* (Landgrebe); *Tennessee* (Landgrebe); *University of Alabama* (Durdin).

Chapter Group P: *Mexico* (to be assigned); *Texas* (Dee); *Texas A & M College* (Dee); *Tri-State* (Dee).

Region No. 7

Regional Vice-President—John R. Russo.

Chapter Group Q: *Northern California, Southern California* and *Utah* (all contacts by Russo).

Chapter Group R: *British Columbia, Oregon, Oregon State College, Washington* (all contacts by Heaton).

Committees Aid Board in Directing AFS Activities

Activities of the American Foundrymen's Society are directed by the Board of Directors working through appointed committees. The Board of Directors consists of the President, Vice-President, immediate Past President and 21 directors.

Seven major committees are outlined in the By-Laws and are designated as standing committees. The members of two, the Executive Committee and the Finance Committee are outlined by the By-Laws. The other five committees are appointed by the President with the approval of the Board of Directors. These committees are: Technical Council, Annual Lecture Committee, Chapter Contacts Committee, Publications Committee, and Exhibits Committee.

Other committees may be designated by the President, subject to approval by the Board.

Committees now functioning were appointed at the first meeting of the Board of Directors held in May, 1958.

The Board at its first meeting also appointed seven Regional Vice-Presidents as provided in a revision of the By-Laws.

Following are the appointments made by the Board.

Regional Vice-Presidents

Region 1—H. G. Stenberg.

Region 2—R. W. Griswold.

Region 3—F. J. Pfarr.

Region 4—C. E. Drury.

Region 5—A. M. Slichter.

Region 6—K. L. Landgrebe, Jr.

Region 7—J. R. Russo.

EXECUTIVE COMMITTEE — Under new By-Laws committee consists of President, Vice-President, immediate Past President and all Regional Vice-Presidents.

CHAPTER CONTACTS — C. E. Nelson Chairman, all Regional Vice-Presidents and all Directors are members.

FINANCE COMMITTEE — Chairman L. H. Durdin, C. E. Nelson, H. W. Dietert, Wm. W. Maloney, E. R. May.

BOARD OF AWARDS — Chairman W. L. Seelbach, I. R. Wagner, Collins L. Carter, Frank J. Dost, B. L. Simpson, F. W. Shipley, H. W. Dietert.

NOMINATING COMMITTEE — Chairman H. W. Dietert, F. W. Shipley (six others to be selected by Executive Committee).

T&RI TRUSTEES — Chairman H. Bornstein, H. W. Dietert, I. R. Wagner, L. H. Durdin, B. C. Yearley, C. E. Nelson, R. A. Oster.

LECTURE COMMITTEE — Chairman B. L. Simpson, M. E. Brooks, A. L. Hunt, H. H. Wilder, V. E. Zang.

PUBLICATIONS COMMITTEE — Chairman D. C. Colwell, T. E. Barlow, T. T. Lloyd, F. L. Riddell, C. E. Sims, H. H. Wilder.

MEMBERSHIP ANALYSIS — Chairman R. W. Griswold, C. E. Drury, A. A. Hochrein, A. V. Martens, C. A. Sanders, F. J. Pfarr, T. W. Curry.

EXHIBITS ANALYSIS — Chairman C. A. Sanders, R. R. Deas, Jr., R. W. Griswold, K. L. Landgrebe, Jr., H. M. Patton, G. R. Rusk.

BOARD NOMINATION — Chairman C. E. Nelson, A. M. Slichter, H. G. Stenberg.

CASTINGS COUNCIL — L. H. Durdin and C. E. Nelson.

F.E.F. TRUSTEES — A. V. Martens, Wm. D. Dunn, W. L. Kammerer to be appointed in December.

Foundrymen discuss maintenance problems at **Plant and Plant Equipment** session at 62d Castings Congress & Foundry Show. Left to right are Committee Chairman James Thomson and speakers F. J. Dost and G. P. Ribar, both of Sterling Foundry Co., Wellington, Ohio and W. Huelsen, Caterpillar Tractor Co., Peoria, Ill.

T&RI Industrial Engineering Course Shows How to Reduce Costs in Foundry

■ Cutting foundry costs through time study and work measurement will be presented Sept. 15-19 at the Marquette University Management Center, Milwaukee.

This basic course is sponsored by the AFS Training & Research Institute and presented by Marquette University Management Center. An advanced course will be presented in December.

The course is recommended for industrial engineers, time study and supervisory personnel. It will explain how work standards are developed and applied to foundry operations. Three days will be devoted to lectures and in making time studies.

Two days will be devoted to panel discussions with Dr. M. E. Mundel, Marquette University Management Center, acting as leader. Panel members will be: C. Gehr, John Deere VanBrunt Co., Horicon, Wis.; Norman Ruehl, International Harvester Co., Milwaukee; and J. A. Westover, Westover Corp., Milwaukee.

On Monday the panel will discuss "Why, Where and When to Use Time Study to Bring Costs Down in the Foundry." On Friday they will conduct a session on "How to Use Time Studies to Bring Down Costs," including an explanation of organization, assignments, duties; tying in with costing, pricing and production.

For further details write to Director, Training & Research Institute, Golf & Wolf Roads, Des Plaines, Ill.

New Chapter Director

■ Copies of the 1958-59 Director of Chapter Officers and Directors are being mailed to all Chapter Officers and Committee Chairman listed in the publication.

Five Regionals Set for October

■ Five AFS regional foundry conferences scheduled for 1958 are concentrated in the latter part of October. The conference dates, locations and sponsoring chapters:

Oct. 15-16—Michigan Regional Foundry Conference, University of Michigan, Ann Arbor, Mich. Sponsored by the Central Michigan, Detroit, Saginaw Valley and Western Michigan Chapters.

Oct. 16-17—All-Canadian Regional Conference, Royal Connaught Hotel, Hamilton, Ont. Sponsored by Ontario and Eastern Canada Chapters.

Oct. 17-18—New England Regional Foundry Conference, Massachusetts Institute of Technology, Cambridge, Mass. Sponsored by the Connecticut and New England Chapters.

Oct. 30-31—Purdue Cast Metals Conference, Purdue University, Lafayette, Ind. Sponsored by the Central Indiana and Michigan Chapters and Purdue University.

Oct. 31-Nov. 1—Northwestern Regional Foundry Conference, Multnomah Hotel, Portland, Ore. Sponsored by the British Columbia, Oregon and Washington Chapters and the Oregon State College Student Chapter.

Michigan Regional

W. C. Truckenmiller, Albion Malleable Iron Co., Albion, Mich., is Chairman of Michigan Regional Foundry Conference. David I. Jacobson, Grand Haven Brass Foundry, Grand Haven, Mich. is program chairman.

Purdue Conference

"Tricks of the Trade, Practical, Simple, Cheap" has been selected as the theme of the Purdue Metals Casting Conference. W. E. Patterson, Elkhart Foundry & Machine Co., Elkhart, Ind., is serving as conference chairman and Dallas F. Lunsford, Perfect Circle Corp., Hagerstown, Ind., serves as program chairman.

Two simultaneous sessions will be held for ferrous and non-ferrous interests and joint meetings will be conducted for panel discussions and technical talks. Clyde A. Sanders, American Colloid Co., Skokie, Ill., will be the Thursday night banquet speaker talking on "New Developments and Thinking in European Foundries."

All-Canandian Conference

A. Reyburn, John Bertram & Sons, Ltd., Dundas, Ont. is chairman All-Canadian Conference and J. Kellum, Electro Metallurgical Co., Ltd., Welland, Ont., is program chairman.

Cupola Course Tells How to Reduce Melting Costs

Increasing cupola efficiency through a better understanding of basic considerations attracted 47 foundrymen from the United States, Mexico, Canada and Korea at the T&RI *Cupola Melting of Iron Course* presented July 7-11 in Chicago.

The 5-day lecture course included discussions of cupola design construction and operation, raw materials, controls and metallurgy.

Preparing the cupola bed, control of melting temperature and rate and coke were presented by E. J. Burke, Hanna Furnace Co., Buffalo, N. Y.

W. W. Levi, Lynchburg Foundry Co., Radford, Va., conducted sessions involving metal control, cupola records, desulfurizers, finishing the heat, cupola lining, slagging, operating problems and forehearth and ladles.

S. C. Massari spoke on raw materials purchasing, combustion in the cupola, metallurgy of cast iron and equipment for metal temperature measurement.

Three foundry industry authorities contributed their time as instructors. T&RI Director S. C. Massari and Safety, Hygiene and Air Pollution Director H. J. Weber also served as lecturers.

Discussions on cupola design and construction, raw materials handling equipment, alloys, charge preparation and blast fundamentals were covered by R. W. Carpenter, Hanna Furnace Corp., Buffalo, N. Y.

Cupola emissions including control ordinances and the available methods of control were explained by H. J. Weber.

T&RI Training Supervisor R. E. Betterley, in reviewing the course, emphasized the high caliber of the men attending as shown by the achievement test.

Foundrymen from three nations attend Cupola Melting course. **Arthur Sanders,** American Seating Co., Grand Rapids, Mich., demonstrates to an audience composed of **James Vander Muelen** also of American Seating Co.; **Oscar Fortney,** Atlas Foundry Co., Marion, Ind.; **Andrew Fuchs,** Fundidora Panamericana S.A., Mexico City, Mexico; and **C. H. Poire,** Montreal Technical School, Montreal, Canada.

Instructor **E. J. Burke,** Hanna Furnace Corp., Buffalo, N.Y., holds informal meeting with students **Nick Mumley,** Centre Foundry & Machine Co., Wheeling, W. Va.; **Jerry L. Hoffman,** Alabama By-Products Corp., Birmingham, Ala.; **Archie Brown,** J. B. Clow & Sons, Coshocton, Ohio; and **Norman A. Grieg,** Centre Foundry & Machine Co., Wheeling, W. Va.

1958 T&RI Courses

Industrial Environment — **Sept. 8-12—Chicago**
Demonstration and lecture course on in-plant environmental problems and safety. Appropriate for foremen, supervisors, engineers, safety men and top management. Registration fee $65.

Metallography of Non-Ferrous Metals* — **Sept. 15-17—Chicago**
Lecture course for melters, supervisors, foremen, foundry engineers, researchers, laboratory technicians, metallurgists and design engineers. Registration fee $40.

Industrial Engineering* — **Sept. 15-19—Milwaukee**
Lecture and work shop course on better standards and cost control. Rating and motions and time study techniques. Registration fee $125.

Product Development — **Sept. 24-26—Chicago**
Lecture course on product analysis from design to marketing of finished castings. Scheduled for foundry engineers, sales engineers, technicians, supervisors, metallurgists and management. Registration fee $40.

Air Pollution Control & Legislation — **Oct. 1-3—Chicago**
Lecture course covering the laws and interpretation, problems, suggested solutions and the drafting of ordinances from the foundry standpoint. Registration fee $40.

Gating & Risering of Ferrous Castings — **Oct. 27-31—Chicago**
Lecture course on the problems relating to gating and risering. Intended for foremen, technicians, foundry engineers, supervisors, industrial engineers and production and quality control personnel. Fee $65.

Foundry Plant Layout — **Nov. 10-12—Chicago**
Lecture course on problems of rehabilitation or building of new plants. Intended for foremen, supervisors, industrial and production engineers and management. Registration fee $40.

Advanced Industrial Engineering* — **Dec. 8-12—Milwaukee**
Work sampling, rating practices, quality control including uses of motion pictures in these phases. Registration fee $125.

*Courses originally scheduled for other dates.

For further details on September courses fill out forms found on FOUNDRY FACTS pages of this issue.

Payment of tuition fees should accompany enrollment application. Make reservations only with Director, AFS Training & Research Institute, Golf & Wolf Roads, Des Plaines, Ill. Tel VAnderbilt 4-0181.

Central Indiana, Purdue Jointly Sponsor Course

■ A 16-week course on Gray Iron Metallurgy will be jointly sponsored by the Central Indiana Chapter and Purdue University. The course starting Sept. 23 will be held in Indianapolis with S. G. Johnson, foundry metallurgist, International Harvester Co., Indianapolis, as instructor.

The course is non-credit for a degree at Purdue University, students successfully completing course will be given a certificate of completion.

Included in the course will be melting of cast iron, gray iron foundry practice, metallurgy, heat treatment and casting design consideration.

Past Presidents shown at luncheon during 1958 Convention. Seated left to right: W. L. Seelbach, G. H. Clamer, W. R. Bean, R. J. Teetor, E. W. Horlebein. Standing left to right F. W. Shipley, D. N. Avey, B. L. Simpson, F. J. Dost, C. L. Carter, H. Bornstein, F. J. Walls, L. N. Shannon.

Canadian Conference Stresses Processes, Quality Control

■ Controls and processes will be featured at the 7th All-Canadian Conference to be held Oct. 16-17 at the Royal Connaught Hotel, Hamilton, Ont.

Six technical talks will be presented by foundrymen from Canada and the United States. Six ferrous and non-ferrous foundries in the Hamilton area will be open to visitors during the morning.

The Conference is sponsored jointly by the Ontario and Eastern Canada AFS chapters. A. Reyburn, John Bertram & Sons Ltd., Dundas, Ont., is the Conference Chairman. F. Kellum, Electro Metallurgical Co., Ltd., Welland, Ont., is the Program Chairman.

The program:

THURSDAY OCT. 16

9:00 am – Registration.
10:00-12:00 am – Plant Visitations: A. H. Tallman Bronze Co., Ltd. Steel Co. of Canada, Ltd. International Harvester Co. of Canada, Ltd.
2:00-3:00 pm – *Light Metals vs. Ferrous Metals*, H. Gravlin, Chrysler Corp., Detroit.
3:00-4:00 pm – *The Third Revolution*, S. H. Deeks, Industrial Foundation on Education, Toronto, Ont.
4:00-5:00 pm – *Is Quality Control Old Stuff in the Foundry?*, W. K. Bock, National Malleable & Steel Castings Co., Cleveland.
7:00 pm – Dinner, speaker W. H. Bleakley, Abco, Inc., Erie Pa., *What A Blind Man Sees.*

FRIDAY, OCT. 17

9:00 pm – Registration
10:00-12:00 pm – Plant Visitations: Dominion Foundries & Steel, Ltd. McCoy Foundry Co., Ltd. Canadian Westinghouse Co., Ltd.
2:00-3:00 pm – *Pouring and Gating of Green Sand and Shell Castings*, J. F. Orloff, Central Foundry Div., GMC, Saginaw, Mich.
3:00-4:00 pm – *Science at the Service of the Canadian Foundry Industry*, S. L. Gertsman, Department of Mines & Technical Surveys, Physical Metallurgy Division, Ottawa, Ont.
4:00-5:00 pm – *Molding Sand Control*, A. N. Johnston, American Standard Products (Canada), Ltd.
7:00 pm – Reception and Banquet, speaker to be announced.

A. Reyburn

Purdue Conference Concentrates on Cost Cutting Methods in Foundries

■ How to cut foundry production costs will be the theme of the Purdue Metals Castings Conference to be held Oct. 30-31 at Purdue University, West Lafayette, Ind.

Ferrous and non-ferrous meetings as well as panel discussions and joint sessions will be conducted, all directed toward *Tricks of the Trade, Practical, Simple, Cheap.*

The annual conference is sponsored by the AFS Central Indiana and Michiana Chapters and Purdue University. W. E. Patterson, Elkhart Foundry & Machine Co., Elkhart, Ind., is Conference Chairman. Dallas F. Lunsford, Perfect Circle Corp., Hagerstown, Ind., is the Program Chairman.

The program:

THURSDAY, OCT. 30

9:00 am–Registration.
10:00 am–Chairman W. E. Patterson, Elkhart Foundry & Machine Co., Elkhart, Ind.
Welcome, Dr. Edward W. Comings, Head of School of Chemical & Metallurgical Engineering.
Response, Charles E. Nelson, Dow Chemical Co., Midland, Mich.
10:45 am–**Sand Processing Panel**
Chairman T. E. Smith, Central Foundry Div., GMC, Danville, Ill.
Gray Iron & Malleable – Robert Clark, Dalton Foundry, Warsaw, Ind.
Non-Ferrous–John Fulwiter, Fabricast Div., GMC, Bedford, Ind.
General Session – T. W. Seaton, American Silica Sand Co., Ottawa, Ill.
1:30 pm–**Non-Ferrous**
Chairman Robert Langsenkamp, Langsenkamp-Wheeler Brass Works, Indianapolis.
Melting and Fluxing of Non-Ferrous Metals, Harry Ahl, Malleable Iron Fittings Co., Branford, Conn.
1:30 pm–**Ferrous**
Chairman Philip Semler, Auto Specialties Co., St. Joseph, Mich.
Inoculation of Irons – Advantages and Control, Ralph Clark, Electro Metallurgical Co., Div. Union Carbide Corp., Cleveland.
3:00 pm–**Non-Ferrous**
Chairman Roy Payne, Sterling Brass Foundry Inc., Elkhart, Ind.
Principles of Effective Gating – Copper and Aluminum Alloys, J. G. Kura, Battelle Memorial Institute, Columbus, Ohio.
3:00 pm–**Ferrous**
Chairman Floyd Crowley, Benton Harbor Malleable Corp., Benton Harbor, Mich.
Ductile Iron, Eric Welander, John Deere, Inc., East Moline, Ill.
6:00 pm–**Banquet**
Master of Ceremonies Prof. R. W. Lindley, Purdue University.
New Developments and Thinking in European Foundries, C. A. Sanders, American Colloid Co., Skokie, Ill.

FRIDAY, Oct. 31

9:30 am–**Joint Session**
Chairman Jack Sickman, Swayne-Robinson Foundry Co., Richmond, In *Practical Cost Concepts for the Small and Medium Sized Foundries*, Ashley C. Sinnett, Terre Haute Malleable Co., Terre Haute, Ind.
11:00 am–**Joint Session**
Chairman A. R. Lindgren, Jr., Magnaflux Corp., Indianapolis.
Non-Destructive Testing for Large and Small Foundries, Harry Day, Auto Specialties Mfg. Co., St. Joseph, Mich.
1:30 pm–**Panel Discussion**. *Diversification for the Foundry–Means of Survival.*
Chairman C. T. Marek, Purdue University.
Diversification of the Processes, Sam Hodler, Golden Foundry Co., Columbus, Ind.
Diversifying the Customer, William Truckenmiller, Albion Malleable Iron Co., Albion, Mich.
Need and Willingness to Serve the Customer, Walter A. Scott, Central Foundry Div., GMC, Danville, Ill.

Name Officers for Penn State Foundry Conference

■ Plans are underway for Pennsylvania State University's Foundry Conference to be held June 25-27, 1959 at University Park, Pa.

Officers for the Conference are: **Honorary Chairman**, Kenneth L. Holderman, assistant dean, College of Engineering and Architecture, Penn State; **General Chairman,** E. J. Biller, Vulcan Mold & Iron Co., Latrobe, Pa.; **Vice-Chairman,** C. W. Mooney, Jr., Olney Foundry, Link-Belt Co., Philadelphia; **Secretary,** W. P. Winter, assistant professor of industrial engineering, Penn State.

Details will be handled by co-chairmen of the program committee: Harold C. Erskine, Aluminum Co. of America, Pittsburgh, Pa. and E. C. Troy, Pennsylvania Electric Steel Castings Co., Hamburg, Pa.

major AFS meetings

SEPTEMBER

8-12 . . . **T&RI Industrial Environment course,** Hamilton Hotel, Chicago.
15-17 . . . **T&RI Metallography of Non-Ferrous Metals course,** Hamilton Hotel, Chicago.
15-19 . . . **T&RI Basic Industrial Engineering course,** Marquette University Management Center, Milwaukee.
26-26 . . . **T&RI Product Development course,** Hotel Sherman, Chicago.

OCTOBER

1-3 . . . **T&RI Air Pollution Control & Legislation course,** Hamilton Hotel, Chicago.
14 . . . **Region 4 Administration Meeting,** University of Michigan, Ann Arbor, Mich.
15 . . . **Region 2 Administration Meeting,** Royal Connaught Hotel, Hamilton, Ont.
15-16 . . . **Michigan Regional Foundry Conference,** University of Michigan, Ann Arbor, Mich. Sponsors: Central Michigan, Western Michigan, Detroit, Saginaw Valley Chapters; Michigan State University and University of Michigan.
16-17 . . . **All-Canadian Regional Foundry Conference,** Royal Connaught Hotel, Hamilton, Ont. Sponsors: Ontario and Eastern Canada Chapters.
16 . . . **Region I Administration Meeting,** Hotel Statler, Boston.
17-18 . . . **New England Regional Foundry Conference,** Massachusetts Institute of Technology, Cambridge, Mass., Sponsors: New England and Connecticut Chapters.
20 . . . **Region 5 Administration Meeting,** Astor Hotel, Milwaukee.
27-31 . . . **T&RI Gating & Risering of Ferrous Castings course,** Hamilton Hotel, Chicago.
30-31 . . . **Purdue Metals Casting Conference,** Purdue University, Lafayette, Ind. Sponsors: Central Indiana, Michiana Chapters; Purdue University.
31-Nov. 1 . . . **Northwest Regional Foundry Conference,** Multnomah Hotel, Portland, Ore. Sponsors: Washington, Oregon, British Columbia Chapters; Oregon State College Student Chapter.

NOVEMBER

7 . . . **Region 6 Administration Meeting,** Peabody Hotel, Memphis, Tenn.
10-12 . . . **T&RI Foundry Plant Layout course,** Hamilton Hotel, Chicago.

DECEMBER

8-12 . . . **T&RI Advanced Industrial Engineering course,** Marquette University Management Center, Milwaukee.
8 . . . **AFS Nominating Committee, Annual Meeting,** Sherman Hotel, Chicago.
9 . . . **AFS Board of Awards, Annual Meeting,** Union League Club, Chicago.
10 . . . **T&RI Trustees, Mid-Year Meeting,** Union League Club, Chicago.

JANUARY

16 . . . **Region 3 Administration Meeting,** Hotel Statler, Cleveland.

FEBRUARY

11 . . . **AFS Board of Directors, Spring Meeting,** Palmer House, Chicago.
12-13 . . . **Wisconsin Regional Foundry Conference,** Schroeder Hotel, Milwaukee.
26-27 . . . **Southeastern Regional Foundry Conference,** Hotel Tutwiler, Birmingham, Ala. Sponsors: Birmingham, Tennessee Chapters; University of Alabama Student Chapter.

MARCH

12 . . . **Region 7 Administration Meeting,** Huntington Hotel, Pasadena, Calif.

APRIL

13-17 . . . **AFS Castings Congress & Engineered Castings Show,** Hotel Sherman and Morrison, Chicago.

Oct. 15 New Deadline for Technical Papers

■ Authors are reminded by Technical Director S. C. Massari that the deadline for receipt of technical papers has been advanced to Oct. 15. An earlier deadline will permit the preprinting of a greater number of papers in the TRANSACTIONS section of MODERN CASTINGS.

Massari in reporting on AFS technical affairs credited the preprinting of technical papers in MODERN CASTINGS with materially helping to stimulate both oral and written discussion of papers presented at the 62d Castings Congress.

Attendance List for 1958 Show Available

■ Names, titles, company affiliation and locations of all 12,444 foundrymen attending the 1958 Foundry Show are now available in a Registered Attendance List.

Exhibitors are entitled to two free copies of the printed booklet upon request. Others may purchase the AFS-compiled book for $25.

Dr. Veli Aytekin, Director of Research, Turkish Iron and Steel Industry, Karabuk, Turkey, visited AFS National Headquarters in July. Aytekin discussed technical affairs with AFS Technical Director **S. C. Massari** (right). Aytekin is an Eisenhower Exchange Fellow studying the latest developments in iron and steelmaking. He will complete a 9-month tour of the United States in October.

New Books and Reprints Scheduled for Release

■ Two new publications and three reprinted publications or revised editions are scheduled for release during 1958-59. A fourth book was approved by the Publications Committee for printing during 1959-60.

New publications are NOISE CONTROL MANUAL and RADIATION HAZARDS. Revisions to be published are PATTERNMAKERS MANUAL and FOUNDRY CORE PRACTICE. The book STATISTICAL QUALITY CONTROL will be reprinted.

MOLDING METHODS & MATERIALS, covering all molding materials and methods in use at the present time will be published during the following fiscal year.

Direct 1959 Technical Program to Casting Buyers, Designers

A coordinated, effort on promoting the use of castings will be conducted on an industry-wide basis at the 63d Castings Congress and 2d Engineered Castings Show sponsored by the American Foundrymen's Society.

Exhibitions will show how castings can solve specific problems through flexibility, quality and economy.

The technical program is being developed to show castings buyers and designers new techniques, new metals and new markets.

Each of the AFS technical divisions and general interest committees will provide papers aimed specifically at casting buyers and designers. In addition to technical papers each division will provide two representatives to assist in preparing a special display of the casting industry.

The tentative technical program consists of sessions by 15 divisions and general interest committees made up of 36 technical meetings, eight luncheons and five shop courses.

Five technical sessions will be conducted by the Sand Division, three each by Light Metals, Steel, Brass & Bronze, Gray Iron and Ductile Iron.

Two sessions will be held by the Malleable and Die Casting and Permanent Mold Divisions as well as Industrial Engineering, Fundamental Papers and Heat Transfer Committees. Both the Education Division and Plant and Plant Equipment Committees will hold one session.

Two shop courses will be sponsored by the Malleable Iron and Gray Iron Divisions. A fifth will be presented by the Sand Division.

Competition Starts Oct. 1 in 1959 Kennedy Memorial Apprentice Contest

■ Patterns and blueprints for use by contestants in the 1959 Robert E. Kennedy Memorial Apprentice Contest have been completed. Contest opens Oct. 1, closes March 16, 1959.

Each contestant must receive, prior to his entering conpetition, a copy of the Official Rules and Regulations outlining the contest. Contestants are not permitted to examine pattern or blueprint prior to entering the competition. All work must be completed without consultation, advice or help.

Molding Entries and Time

All castings must be made in green sand molds only. If baked cores are needed it is not required that they be made by the contestant. All castings must be blasted but shall not be coated, ground, chipped or welded. Gates and risers must not be removed.

Molding time shall commence when contestant personally receives the pattern and shall include all planning and study, closing the mold, and clamping or weighting ready for pouring.

Pattern Entries and Time

Patternmaking time shall commence when the contestant personally receives the blueprint and must include all planning and study. Shellac must be applied but may still be wet when the contestant relinquishes his pattern. Pattern entries shall be coated only as specified on the blueprint. Standard pattern colors must not be used.

Casting entries—wire tag to casting. Stamp or clearly mark contest registry number on the body of casting in numerals at least 1/4-in. high.

Wood pattern entries—Do not affix identification tags to parting surfaces. Identify each loose piece with assigned contest registry number using India ink. Numerals must be at least 1/4-in. high on clear surfaces.

Metal pattern entries—Affix identification tag. Identify each loose piece with assigned contest registry number by stamping or clearly marking numerals at least 1/4-in. high.

Contest identification tags are furnished by the AFS Central Office or in the case of local contests by the local contest committee. Each tag shall include only the AFS-assigned registry number, time consumed in completing the entry and with castings the gross weight and approximate metal analysis.

Successful entries from local chapter contests or individual plant contests must be shipped only to Prof. R. W. Schroeder, University of Illinois, Navy Pier, Chicago. Transportation charges on all contest entries must be prepaid.

Submit Progress Reports

■ Committees of the Sand Division reported on their activities at the June meeting of the Sand Divison Executive Committee held in Chicago.

Following are summaries of the committees:

Core Test Committee—Three projects active: revision of the core sections of the SAND TEST HANDBOOK; test procedures being developed for silicate bonded and air-set bonded sands. The Executive Committee recommended that the new acid-type binders be included in the development of the test procedures.

Bakeability Committee—Project not completed.

Flowability Committee—Evaluation work remains on last series of flowability tests.

Grading & Fineness Committee—The following projects are underway: evaluation of AFS clay determination test; statistical analysis of sampling investigation; literature survey in fields of soil mechanics and ceramics on distribution of particles; revision of parts of SAND TESTING HANDBOOK.

Mold Surface Committee—Evaluating Wood's metal castings poured during the summer.

Physical Properties of Iron Foundry Molding Materials at Elevated Temperature Committee—Investigating veining tendencies.

Core Stickiness Committee—Investigating its original problem of core stickiness.

Physical Properties of Steel Foundry Sands at Elevated Temperature Committee—Embarking on long-range program on causes and prevention of non-metallics in steel castings.

Molding Methods & Materials Committee—Working on proposed handbook.

Sand Handbook Revision Committee—Committee is being organized.

Shell Mold & Core Committee—Working on expansion of shell molds. Chapter on shell molds being revised for new handbook. Long-term projects are evaluation of an investment test, a melt point test for resins and some type of resin control test.

Controlled Casting Quality Committee—Has held number of meetings and will hold 2-day meeting in the fall.

Basic Concepts Committee—Will continue work reported in four papers at the 1958 Convention.

Canadian Committee—Preparing survey of foundry sands available in Canada.

West Coast Committee—In process of being formed.

Sand Division Reviews Casting Solidification

■ Progress of the thermodynamics of casting solidification being conducted at Battelle Memorial Institute has been reviewed by the Research Committee of the Light Metals Division.

Five suggestions were made as to phases to be kept in mind as work progresses. These are:

- Effect of area of junction of riser to casting.
- Properties of bars cut from experimental castings correlated with quality.
- Effect of air gap on chill effectiveness and chill position.
- Effect of riser height on feeding characteristics.
- Effect of insulating the riser.

Malleable Outlines Project Procedures

■ Methods of conducting future experiments in the Malleable Iron Division-sponsored research at the University of Wisconsin were adopted at a June meeting of the Research Committee.

The committee also reviewed the first progress report submitted in May by the University.

Procedures endorsed by the committee:

(a) All melts shall be conducted under an atmosphere containing 21 per cent carbon dioxide and 79 per cent nitrogen, with a flow rate of 0.78 cu ft gas per min.

(b) Melting time in the furnace shall be held to 70-80 min. Holding temperature shall be 2800 F.

(c) Composition shall be adjusted so that it will produce a white 4x4x8-in. test block without other element additions. Sufficient tests shall be run so as to establish the shift in the base line as compared to the 2-in. bar.

(d) Melts shall be made to study the effect of bismuth on the curves, the effect of water vapor on the curves, the combined effect of water vapor and bismuth on the curves.

(e) Present method of bismuth additions shall be continued and those additions shall be made at a melt temperature of 2750 F and the test castings poured at 2700 F.

Clinic Tackles Heat Transfer Questions

■ Heat transfer problems encountered in various foundry operations were covered at a heat transfer clinic conducted at the 62d Castings Congress.

Foundrymen were encouraged to submit their questions to the 5-man panel. Among the subjects covered were sand mold-wall movement, quenching of malleable iron, controlling sand properties to affect solidification times, use of radiant heat reflectors over risers to prolong feeding time, heat transfer in joining end quench test, application of mathematical equations to aid in predicting casting freezing time, semi-continuous direct-chill casting process, relationship between heat flow and residual stresses in castings and heat transfer in car-type heat-treating furnaces.

The meeting was opened with a discussion by R. W. Ruddle who reviewed areas in foundry operations in which heat transfer considerations arise.

Members of the panel were Heat Transfer Committee Chairman Dr. W. K. Bock, National Malleable & Steel Castings Co., Cleveland; C. K. Donoho, American Cast Iron Pipe Co., Birmingham Ala.; Dr. Victor Paschkis, Columbia University, New York; R. W. Ruddle, Foundry Services, Inc., Columbus, Ohio; R. C. Shnay, Canada Iron Foundries Ltd., Toronto, Ont.

Heat Transfer clinic at 62d Castings Congress covered variety of problems submitted by the audience. Panelists are Dr. Victor Paschkis, R. C. Shnay, C. K. Donoho, R. W. Ruddle and Heat Transfer Committee Chairman W. K. Bock.

Gray Iron Division Makes Plans for 1959 Convention

■ Two shop courses, one round-table discussion and three technical sessions will be conducted by the Gray Iron Division at the 63d Castings Congress. A fourth technical session may also be sponsored.

Initial plans for the 1959 technical program were made at a meeting of the division's Executive Committee and Program & Papers Committee in June. Two technical papers will be of direct interest to design engineers or casting buyers.

During the 1958 Convention a total of 12 papers were presented with only two coming from gray iron foundries. Efforts will be made to acquire a better representation from this source.

The division will also consider submitting, in 1959, a technical paper to the Institute of British Foundrymen and/or the International Foundry Congress to be held in Madrid, Spain.

Appointments

Awards Subcommittee—to recommend nominees for Gold Medals, Awards of Scientific Merit and Service Citations. Members: J. S. Vanick, C. K. Donoho, R. A. Clark and D. E. Krause.

Nominating Committee—to make recommendations for division offices expiring June 30, 1959. Members: C. K. Donoho, W. Levi and D. E. Krause.

Engineered Castings Exhibit Representatives—to aid in coordinating division activities with the 1959 Castings Show. Members; H. Wilder, S. G. Johnson, Sr.

Cost Committee Plans for 1959 Convention

■ Preliminary planning for participation in the AFS 1959 Convention has been started by the Industrial Engineering & Cost Committee. The program will be designed to emphasize the potential advantages of dynamic industrial engineering activity and proper costing and price procedures.

Efforts will be concentrated on two phases: operations, including developing and maintaining operational control; and financial, based on controlling costs and pricing castings.

Metallography Course Shows How Foundries May Install Program

Designed to cover a wide range of interests, the T&RI *Metallography of Non-Ferrous Metals* course contains valuable information for advanced students as well as beginners.

The 3-day course will enable students to interpret microscopic and macroscopic specimens, prepare their own samples and set up minimum-expense laboratories. It is recommended for melters, supervisors, foremen, engineers, laboratory technicians, metallurgists and design engineers.

A registration fee of $40 is charged for the course to be held Sept. 15-17 at the Hamilton Hotel, Chicago.

Course outline:

DEFINITION OF TERMS AND AREAS—Metallurgy; metallography.

MACROSCOPIC ANALYSIS REVEALS—Grain size; dendritic formations.

DEVELOPMENT OF METALLOGRAPHY—Increase in use of metals; physical and mechanical property demands of metals; need for greater understanding; control; properties revealed by photomicrographs; use as supplement to other testing procedures.

INFORMATION FROM MICROSCOPIC EXAMINATION—Element effects; comparison of similar metal compositions; determining variation in cast products; determination of changes necessary to meet customer's physical requirements; variations in different locations of castings; causes of porosity and discontinuity; direction in control for maximum physical porperties; chemical composition by metallographic techniques; preservation of characteristics.

ALLOY DIAGRAMS—Cooling curves of metals; eutectic alloy; alloy diagrams and meanings; micro appearance of typical examples.

METALLOGRAPHIC PROCEDURES—Sample preparation; visual examination; application of procedures; new equipment available.

Continue Research on Pressure Tightness

Research work on pressure tightness in 85-5-5-5 bronze during the 1958-1959 period will be directed primarily toward defining quantatively the conditions for avoiding leakage in the 2x2-in. cross-section bar.

Research Committe members of the Brass & Bronze Division outlined the following program:

- Complete the standard 2x2-in. test bar.
- Vary the bar length to get a sounder bar with the same size riser and gating system (standard conditions).
- Pour thinner bars (approx. 2x 1/4-in. min) and cut standard 1/32-in. specimens out of the bars.
- Use a larger riser with various bar lengths to determine the riser effect and also see if a sound bar can be produced.
- Have test bars poured at other foundries and sent to the University of Michigan for testing.

A progress report on pressure tightness of 85-5-5-5 bronze at the university for the past year was received in the form of a written progress report and a verbal explanation by R. A. Flinn, University of Michigan.

The effects of the following variables were discussed:

- Pouring temperature effect—The higher the pouring temperature the greater the porosity.
- Chilling—Porosity at critical sections can be greatly decreased by chilling.
- Moisture content—Varying the moisture from 2.6-5.5 per cent did not have a pronounced effect on porosity.
- Sample depth—There was more porosity in the top of the bar due to the flotation of gases.

Die Casting Research Group Making Survey

Preparation of a bibliography on die casting and permanent molding is being prepared as the initial project of the Research Commttee of the Die Casting & Permanent Mold Division. Committee members will review and abstract articles printed during the past ten years.

The committee will deal with all aspects of die casting and permanent mold practice not being pursued by other active committees. Preparation of the bibliography will enable the committee to determine areas requiring further study.

Chapter News

Wisconsin Chapter Holds 23d Annual Outing

Wisconsin Chapter's day-long outing featured golf, bait casting, weight guessing, prizes, lunch, dinner and entertainment. Bait casting in the lagoon was held under ideal summer conditions.

Shown at the **Western New York Chapter** annual spring dance are: Mr. and Mrs. Ronald E. Turner; Mr. and Mrs. Paul Lods, Mr. and Mrs. Edmund J. Burke; and A. J. Heysel.

Approximately 600 members of the **Philadelphia Chapter** and guests attended the annual outing. For the second straight year the suppliers beat the foundrymen in softball. Golfers shown in picture are C. Best, K. Kostenbader and K. Bunk of Bethlehem Steel Co., Bethlehem, Pa.

Largest Spring Salmon (48½ lb) caught to date on the British Columbia Coast was landed by J. C. Sturrock, Associated Foundry, Ltd., Vancouver, B.C. Sturrock's catch is not eligible for the annual British Columbia Salmon Derby but will give Sturrock and other chapter members a challenge.—*J. T. Hornby*

Participating in **Mexico's** May meeting were Chapter Secretary Enrique Leon Andrade, Chairman Vicente Nacher Todo; Education Officer Fernando Gonzalez Vargas and speaker Juan Latapi Sarre who addressed the chapter on manufacture of rolls for the finishing stand of a bar mill.—**Jose A. Perez Casas**

afs chapter meetings

SEPTEMBER

Birmingham District . . *No Meeting.*

British Columbia . . .**Sept. 19** . . Leon's, Vancouver, B. C. . . R. L. Olson, Dike-O-Seal, Inc., *"Modern Pattern Construction."*

Canton District . . *No Meeting.*

Central Illinois . . **Sept. 13** . . Engineers' Club, Groveland, Ill. . . *Fish Fry.*

Central Indiana . . **Sept. 6** . . Lake Shore Country Club, Indianapolis . . *Annual Golf Outing and Picnic.*

Central Michigan . . **Sept. 17** . . Hart Hotel, Battle Creek, Mich. . . D. Barich, Detroit Institute of Technology, *"Management Responsibility for Employee Attitude."*

Central New York . . **Sept. 12** . . Trinkaus Manor, Oriskany, N. Y. . . O. J. Myers, Reichhold Chemicals, Inc., *"Core Binders—Newer Types in New Processes."*

Central Ohio . . **Sept. 8** . . Seneca Hotel, Columbus, Ohio . . *Film, "The Buhrer Automated Molding & Pouring Method."*

Chesapeake . . **Sept. 26** . . Engineers' Club, Baltimore, Md. . . E. J. Mapes, Pickands Mather & Co., *"Taconite Process," and Film, "Erie Taconite."*

Chicago . . *No Meeting.*

Cincinnati District . . **Sept. 8** . . Alms Hotel, Cincinnati . . *Non-Ferrous*: W. M. Ball, R. Lavin & Sons, Inc., *"Brass Foundry Metallurgy"*; *Gray Iron*: H. E. Henderson, Lynchburg Foundry Co., *"Injection Process Nodular Iron."*

Connecticut . . **Sept. 12** . . Belli's Restaurant, North Wilbraham, Mass. . . *Joint Plant Visitation with New England Chapter, Chapman Valve Co., Indian Orchard, Mass.*

Corn Belt . . *No Meeting.*

Detroit . . *No Meeting.*

Eastern Canada . . *No Meeting.*

Eastern New York . . **Sept. 16** . . Panetta's Restaurant, Menands, N. Y. . . H. E. Henderson, Lynchburg Foundry Co., *"Manufacture of Nodular Iron."*

Metropolitan . . *No Meeting.*

Mexico . . **Sept. 22** . . Av. Chapultepec 412, Mexico D.F., Mexico . . C. Ortega, *"Processing of Tungsten."*

Michiana . . *No Meeting.*

Mid-South . . **Sept. 12** . . Claridge Hotel, Memphis, Tenn.

Mo-Kan . . **Sept. 5** . . Fairfax Airport, Kansas City, Kans.

New England . . **Sept. 12** . . Belli's Restaurant, North Wilbraham, Mass. . . *Joint Plant Visitation with Connecticut Chapter, Chapman Valve Mfg. Co., Indian Orchard, Mass.*

Northeastern Ohio . . **Sept. 11** . . Tudor Arms Hotel, Cleveland . . Brig. Gen. J. M. Colby, U.S. Army Ordinance Missile Command, Redstone Arsenal. *Discussion of Missile Program.*

Northern California . . **Sept. 15** . . Spenger's Restaurant, Berkeley, Calif. . . R. L. Olson, Dike-O-Seal, Inc., *"Modern Pattern Construction."*

Northern Illinois & Southern Wisconsin . . **Sept. 9.**

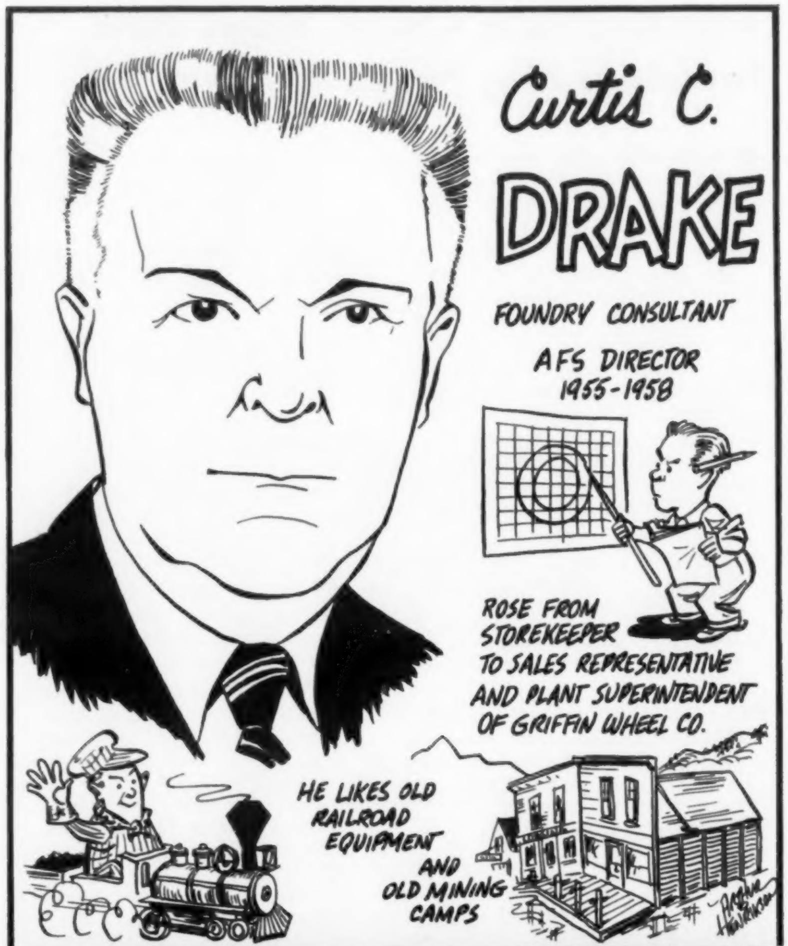
Northwestern Pennsylvania . . **Sept. 22** . . Amity Inn, Erie, Pa. . . R. Lee, Lee Hobby Foundry.

Ontario . . **Sept. 12** . . Royal York Hotel, Toronto, Ont. . . *Gray Iron Group*: J. E. Rehder, Canada Iron Foundries, Ltd., *"New Types of Cupolas"*; *Steel Group*: H. F. Taylor, Massachusetts Institute of Technology, *"Hot Tears in Steel Castings"*; *Non-Ferrous Group*: H. F. Bishop, Exomet, Inc., *"Manufacture of Pressure Tight Non-Ferrous Castings." Recognition Night for Apprentices and Paper Writing Contestants.*

Oregon . . **Sept. 17** . . Heathman Hotel, Portland, Ore. . . R. L. Olson, Dike-O-Seal, Inc., *"Modern Pattern Construction."*

Philadelphia . . *No Meeting.*

Piedmont . . **Sept. 12** . . Hotel Charlotte, Charlotte, N. C. . . C. A. Sanders, American Colloid Co., *"Casting Defects."*



Personalities

Pittsburgh . . **Sept. 15** . . Hotel Webster Hall, Pittsburgh, Pa.

Quad City . . **Sept. 15** . . LeClaire Hotel, Moline, Ill.

Rochester . . **Sept. 6** . . Doud Post, American Legion, Buffalo Road . . *Clam Bake.*

Saginaw Valley . . *No Meeting.*

St. Louis District . . **Sept. 11** . . Edmond's Restaurant, St. Louis . . G. W. Anselman, Whirl-Air-Flow Corp., *"Movement of Sand and Its Properties."*

Southern California . . **Sept. 12** . . Rodger Young Auditorium, Los Angeles. . . R. L. Olson, Dike-O-Seal, Inc., *"Modern Pattern Construction."*

Tennessee . . **Sept. 6** . . Camp Columbus, Chattanooga, Tenn. . . *Annual Barbecue.*

Texas . . **Sept. 19** . . University of Houston, Houston, Texas . . J. R. Hewitt, Houston Equipment Co., *"Steel Melting."*

Timberline . . **Sept. 8** . . Oxford Hotel, Denver, Colo. . . H. W. Schwengel, Modern Equipment Co., *"New Developments in Equipment for Melting & Charging" and Film.*

Toledo . . *No Meeting.*

Tri-State . . **Sept. 12** . . Alvin Plaza Hotel, Tulsa, Okla. . . R. L. McIlvaine, National Engineering Co., *"Foundry Layout & Maintenance."*

Twin City . . **Sept. 9** . . Jax Cafe, Minneapolis . . C. A. Sanders, American Colloid Co., *"What European Foundrymen Are Doing."*

Utah . . *No Meeting.*

Washington . . **Sept. 18** . . Exeter Hotel, Seattle . . R. L. Olson, Dike-O-Seal, Inc., *"Modern Pattern Construction."*

Western Michigan . . *No Meeting.*

Western New York . . *No Meeting.*

Wisconsin . . **Sept. 12** . . Schroeder Hotel, Milwaukee . . *Five Sectional Meetings for Gray Iron, Steel, Malleable, Non-Ferrous and Pattern Groups.*

OCTOBER

Canton District . . **Oct. 2** . . Swiss Club, Canton, Ohio.

Central Illinois . . **Oct. 6** . . Vonachen's Junction, Peoria, Ill.

Chicago . . **Oct. 6** . . Chicago Bar Association, Chicago . . C. A. Sanders, American Colloid Co., *"What European Foundrymen Are Doing."*

Cincinnati District . . **Oct. 13** . . Engineers' Club, Dayton, Ohio . . E. F. Price, Dayton Malleable Iron Co., *"Cleaning and Finishing."*

Detroit . . **Oct. 9** . . Hotel Tuller, Detroit . . *Ferrous Group*: M. H. Horton, Deere & Co., *"Water-Cooled Cupolas—Construction, Operation & Controls"*; *Non-Ferrous Group*: *"Low Frequency Induction Melting."*

Eastern Canada . . **Oct. 3** . . Mount Royal Hotel, Montreal, Que.

Metropolitan . . **Oct. 6** . . Essex House, Newark, N. J.

Mid-South . . **Oct. 10** . . Claridge Hotel, Memphis, Tenn.

Mo-Kan . . **Oct. 3** . . Fairfax Airport, Kansas City, Kans.

Northeastern Ohio . . **Oct. 9** . . Tudor Arms Hotel, Cleveland.

Rochester . . **Oct. 7** . . Manger Hotel, Rochester, N. Y.

St. Louis . . **Oct. 9** . . Edmond's Restaurant, St. Louis . . R. L. Gilmore, Superior Steel & Malleable Castings Co., *"Casting Design."*

Saginaw Valley . . **Oct. 2** . . Fischer's Hotel, Frankenmuth, Mich. . . W. G. Gude, Penton Publishing Co., *"The Future of the Foundry Industry."*

Southern California . . **Oct. 10** . . Rodger Young Auditorium, Los Angeles . . A. B. DeRoss, Kaiser Aluminum & Chemical Sales, Inc., *"Kaiser Aluminum's New Alloy X-357."*

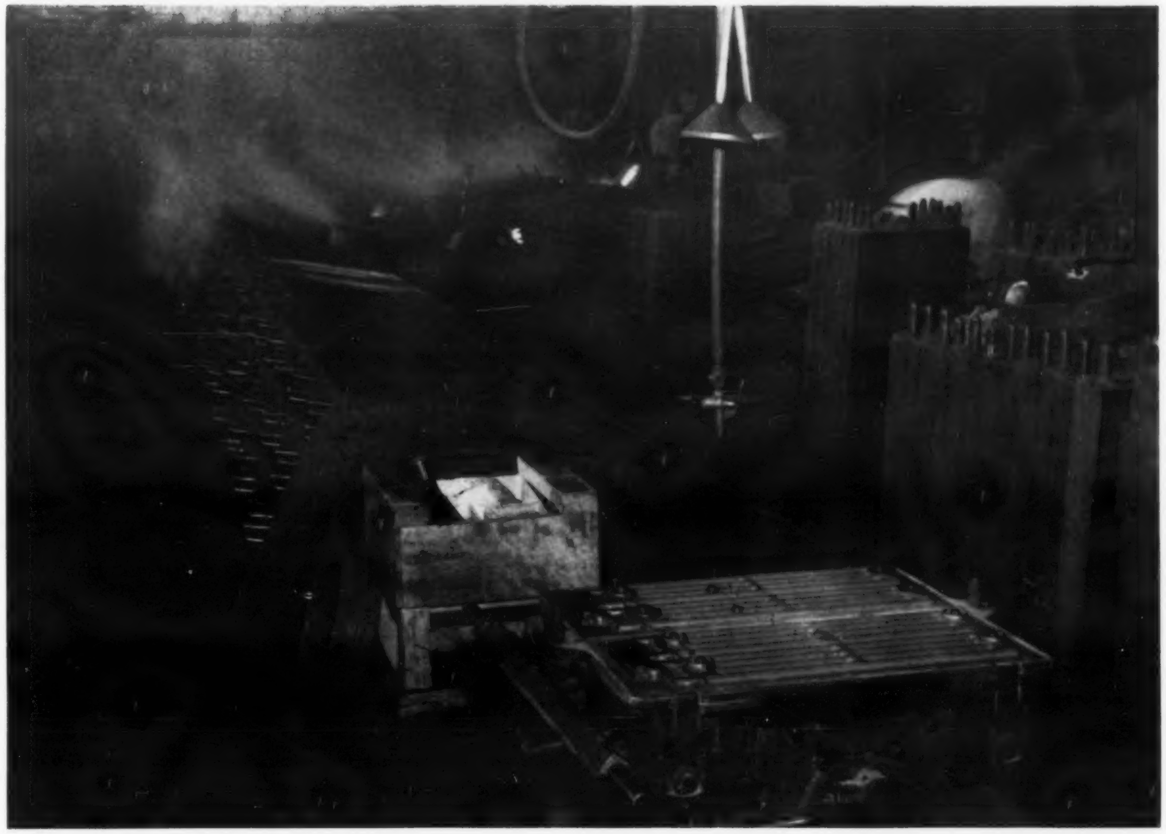
Tri-State . . **Oct. 10** . . Wilder's Restaurant, Joplin, Mo.

Toledo . . **Oct. 1** . . Heather Downs Country Club, Toledo, Ohio.

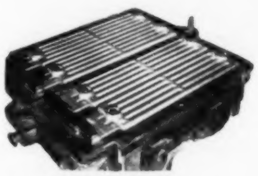
Western Michigan . . Oct. 6 . . Spring Lake Country Club, Spring Lake, Mich.

Western New York . . **Oct. 3** . . Hotel Sheraton, Buffalo, N.Y.

Wisconsin . . **Oct. 10** . . Schroeder Hotel, Milwaukee.

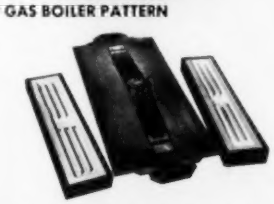


• HEATING RADIATOR PATTERN



• RADIATOR PATTERN

• GAS BOILER PATTERN



• GAS BURNER REVERSE PATTERNS

75% SAVINGS AT WEIL McLAIN FOUNDRY

THE heating radiator pattern shown in top photo at the Weil-McLain Foundry at Erie, Pa., was made from HYSOL TC2204 Plastic Tooling compounds instead of the usual cast iron. Cost for the iron pattern would be $175.00. But the cost for a HYSOL pattern made from a reverse is *only $20.00!*

Of added importance, Weil-McLain officials expect 125,000 castings per pattern or a minimum of 4 years daily production. At the end of this time, the pattern can be repaired in a matter of hours or discarded and another made.

The radiator pattern at left top was also made from HYSOL TC2204. This unit has actually undergone 66,000 runs with only 2 thousandths of an inch wear. A reliable basis for planning many more years of use from the same pattern.

At left center, Mr. Stan Trezenski, Secretary of the American Foundrymen's Society of Erie and assistant foundry superintendent at Weil-McLain, shows HYSOL gas boiler pattern. On this unit alone, $800.00 was cut from older methods of pattern-making. This pattern has already been used two years and 20 additional years of daily production is expected.

The end sections, lower left, are gas burner reverse patterns and the center section is a working pattern again having an estimated four years of use. All are made with HYSOL Plastic Tooling with proven utility and cost benefits.

Down to earth facts from foundrymen that HYSOL Plastic Tooling saves money! This is typical of how HYSOL is helping others and can help you maintain high standards of production with substantial reductions in your costs. Free booklets and technical assistance are available on request.

A product of

HOUGHTON LABORATORIES INC.

OLEAN, NEW YORK

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HYSOL of California, Div. South El Monte, California

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HYSOL (CANADA) LDT.

TORONTO, ONTARIO

Circle No. 816, Page 7-8

AIRETOOL

pneumatic grinders step up this man's hourly production!

Model 700 Horizontal Grinder has up to 8″ bonded wheel capacity at 4500 rpm. Lightweight, portable—steps up output per man-hour.

Remove more metal, reduce operator fatigue with Airetool pneumatic grinders. These versatile, easy-to-operate tools save production time and costs . . . assure profit-making job efficiency.

HORIZONTAL GRINDERS

For general grinding, snagging, buffing and wire wheel work. Model 600 (illustrated) has up to 6″ wheel capacity, at 6000 rpm. Features same balanced design as Model 700. Easy to handle and maneuver. Both Model 600 and Model 700 are lightweight, efficient performers . . . won't heat up under steady use or stall when the going gets tough.

VERTICAL GRINDERS

Your best choice for cup wheel grinding, sanding or fine finishing. Model 700-V has 6″ wheel or brush capacity at 4500 to 6000 rpm. Takes the toughest jobs in stride. Model 600-V handles all medium duty metal removal and finishing jobs easily . . . takes 6″ abrasive wheel, 7″ to 9″ sanding pad, or 7″ to 9″ raised hub disc wheel. Speeds: 4500 to 6000 rpm.

EXTRA HEAVY DUTY DIE GRINDERS

The versatile Model 500 pays for itself in many ways. Can be used for contour grinding or working around irregular shapes on large dies, molds or patterns. Collet attachment permits use of cone wheels or rotary files for fine finishing. Also does fast job deburring castings, forgings or on metal work of any kind. Takes 3″ bonded wheel; speed: 17,000 rpm.

Get this free catalog . . . It will pay you to see how Airetool pneumatic tools can increase production per man-hour, save time and cost on the job. For full details about the complete Airetool line, write for free Catalog No. 63.

BRANCH OFFICES: New York, Chicago, Tulsa, Philadelphia, Houston, Baton Rouge.
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CANADIAN PLANT: 37 Spalding Drive, Brantford, Ontario.

AIRETOOL
MANUFACTURING COMPANY
SPRINGFIELD, OHIO

Circle No. 832, Page 7-8

let's get personal

W. R. Oakley . . . has been appointed vice-president, Delhi Foundry Sand Co., Cincinnati, Ohio. He was formerly in the sales department and is a member, AFS Cincinnati Chapter. **Gerald Scott** former F.E.F. scholarship winner, has been named the Indiana representative of Delhi Foundry Sand Co., Cincinnati, Ohio.

H. B. Missbach . . . Zurich Switzerland, accepted the position of supervisor-foundry of the laboratory operations for Applied Research and Development Laboratory of General Electric Co., Foundry Dept., Schenectady, N. Y.

C. W. Sinclair . . . is the newly-appointed vice-president, engineering, for all divisions of the Kelsey-Hayes Co., Detroit, Mich. He was previously chief engineer for the automotive division and has been with the company since 1911.

W. R. Barber . . . assistant to the vice-president in charge of sales, assumed the responsibilities of administrative manager of the metallurgical department, Electric Steel Foundry Co., Portland, Oregon. **J. E. McQuaid** became general manager and **D. G. Johnson, Jr.**, former advertising manager, joined the sales department as assistant general sales manager. **R. L. Zwald** is the new advertising manager. The organizational changes announced by **R. W. deWeese**, vice-president in charge of sales, will enable the company to concentrate more attention on the fields of marketing, research and development of alloy steel castings.

Richard Hayden . . . former head of the Industrial Furnace Div., Hevi-Duty Electric Co., Milwaukee, Wis., will have charge of gas-furnace sales. He has over 30 years experience in design and sale of gas furnaces. **Norman Acker,** superintendent of furnace-manufacturing shop at Eclipse, will perform liaison work between engineering, sales and production. **William Swanson** will continue to work with automatic heat treating units as sales and service engineer.

P. W. Bakarian . . . has been appointed president and general manager of R-N Corp., owned equally by National Lead Co., and Republic Steel Corp., both of New York. **J. S. Breitenstein** and **R. P. Smith** have been named vice-presidents, the former in charge of administration, the latter in charge of engineering. Bakarian succeeds **Alex Stewart,** retired, who was R-N's first president and general manager and former director of research for National Lead and supervisor of the company's nuclear energy activities.

W. P. Burns . . . has been named manager of the Cleveland Works of National Malleable & Steel Castings

W. R. Barber

J. E. McQuaid

W. P. Burns

Produce More
Top Quality
Castings
with
Top Quality
FOUNDRY MATERIALS

Use these Time-Tested Products for Best Results

SAND
Portage (Wis.) Silica
Century Molding
*Ottawa Blackhawk Silica
Muskegon Lake Sand
Tenn. & Ind. Molding
Utica Crude Silica
Green Lake & St. Marie Shell
*Zircon Sand, Flour and Wash
Berlin Core Sand
Red Flint Annealing & Packing
New Jersey Molding
Gallia Red Molding
Albany Molding

BONDING CLAYS
*Volclay, MX-80 (Granular)
*and Panther Creek Bentonite
*Goose Lake Fire Clay
*Grundite Bonding Clay

ABRASIVES
*Tru-Steel Steel Shot
Mallan' Steel Shot and Grit
*Mallebrasive Shot and Grit
*Certified Shot and Grit
*Blackhawk Sand Blast Sand
*Super-Titan Nozzles

REFRACTORIES & MISC.
Corgan Cupola Gun Mix
Firegan Ganister
*Microsil Silica Flour
Fluxing Limestone
*Five Star & Steel-Flo Wood Flour
*Sultron Foundry Flux
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Circle No. 818, Page 7-8

Co., Cleveland. Burns will replace **Stewart Tame,** Cleveland works manager, retiring after 35 years' service with the firm. Burns, 47, has been with the firm since 1937. He is a

L. G. Blackmon

member of the AFS Northeastern Ohio Chapter. **L. G. Blackmon** will replace Burns as the general superintendent. Blackmon is a member, AFS Pittsburgh Chapter.

N. L. Sattler . . . is the new director of personnel, bronze casting and machine parts, Bunting Brass and Bronze Co., Toledo, Ohio. He will be in charge of employment, industrial relations and related activities according to **W. M. Hankins, Jr.,** president.

Gordon Moline . . . has been promoted to national sales manager, Metallurgical, Inc., Minneapolis, Minn. Moline, former assistant engineer of the Kansas City heat treating plant, has been with the company for four years.

T. R. Elmblad . . . formerly in the Whiting Corp. Chicago district office, has been transferred to the district office at Pittsburgh, Pa. He joined Whiting in 1951 as a draftsman and in 1955 was assigned to the sales force, New York office, specializing in Swenson chemical processing equipment. **George Kleinman** has been promoted to the Whiting Corp. district office located in Charlotte, N. C.

L. R. Gaiennie . . . has been elected vice-president, ACF Industries New York. He succeeds **A. L. Kress,** who remains staff vice-president. Gaiennie's new duties will encompass labor relations, public relations, personnel, wage and salary administration, security and employee benefits.

A. I. Woods . . . has been named Buffalo district manager, covering New York for Latrobe Steel Co., Latrobe, Pa. He is one of the company's foremost salesmen and his background in basic application of tool steels and

better chilled iron abrasives ...and why

We have specialized in the manufacture of metal abrasives since 1888. We have "grown up" with their expanding use. Such long contact with their production and use has given us unequalled know-how and experience in their manufacture.

A continuous program of research for the improvement of metal abrasives has been carried on with one of America's foremost metals research organizations since 1937.

We employ the most modern techniques in melting and processing to produce metal abrasives to exacting standards of chemistry, hardness, toughness and uniformity of these elements from one lot to another. It is more than significant that the two largest manufacturers of blast-cleaning equipment in the world sell and recommend Samson Shot and Angular Grit for best results in their equipment.

MALLEABRASIVE Shot and Grit

TRU-STEEL Shot

LEADERS in development of PREMIUM-TYPE ABRASIVES

The two best known names in premium abrasives were developments of two of our subsidiaries. MALLEABRASIVE, the first malleablized type of metal abrasive ever produced, set the pace for development of all other makes of premium abrasives. TRU-STEEL Shot was the first high-carbon all steel shot produced to meet demand for this specialized type of abrasive.

One of these products may do your blast-cleaning job better, and at lower cost. Write us for full information.

PITTSBURGH CRUSHED STEEL CO.
Arsenal Sta., Pittsburgh 1, Pa.
Subsidiaries: - - -
The Globe Steel Abrasive Co., Mansfield, O. (Malleabrasive)
Steel Shot Producers, Inc., Arsenal Sta., Pittsburgh (Tru-Steel)

Circle No. 819, Page 7-8

NEW!

AIR POLLUTION MANUAL

exclusively prepared for

THE FOUNDRY INDUSTRY

In the eyes of the public, the Foundry Industry is a major source of Air Pollution! Yet, in a comparison with other basic industries, less equipment is needed by the foundry industry to reduce pollution of the air by contaminants than in the others.

In the light of existing conditions, the Foundry Industry's major problem is to have technically accurate information for controlling air pollution in specific operations and locales.

Only in this way can Foundry Operators proceed with confidence in establishment of community relations and development of laws, equally compatible for industrial and residential acceptance.

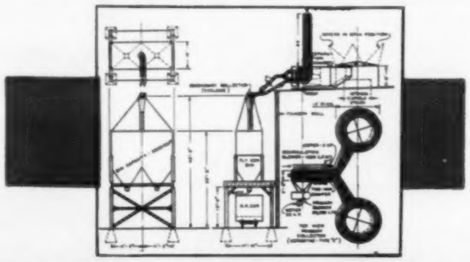
This **AIR POLLUTION MANUAL,** written by men of the foundry field for the foundry field, will enable management to move forward with confidence . . . not only in the selection and maintenance of suitable equipment but, equally important, in compliance with "good neighbor" policies.

Comprehensive sections cover:

1. **Foundry Industry's Air Pollution Problem**
2. **Review of Existing Ordinances**
3. **Community Relations**
4. **Atmospheric Sampling and Analysis**
5. **Air Cleaning Equipment**
6. **Operating Methods, Improvements and Maintenance**

Here, at last, is a book that will enable Foundry Management to *know* how to correct the air pollution problem as it affects their plant and their community interests. Order your copies of the **AFS AIR POLLUTION MANUAL** today!

$4.25 . . . AFS Members $6.50 . . . Non-Member Price



AFS

AMERICAN FOUNDRYMEN'S SOCIETY
Golf and Wolf Roads
Des Plaines, Illinois

Please send_____copies of the AFS AIR POLLUTION MANUAL.

☐ Remittance Enclosed. ☐ Send Invoice.

Name________ Title________

Company________

Address________

City________ Zone____ State________

high-temperature alloys will be of great assistance to the metalworking industry in that area.

H. C. Ahl . . . has assumed the position of assistant to the manager, castings sales, Malleable Iron Fittings Co., Branford, Conn. He will apply himself to the marketing and sales of custom steel and malleable iron castings.

A. I. Nussbaum . . . has been appointed vice-president of Loma Machine Mfg. Co., New York, and its affiliate company, Lobeck Casting Processes Inc., New York. He joined the organization in 1956 as manager of the Rolling Mill division and has been engaged in ferrous and nonferrous metals processing, engineering and sales for the past 14 years.

E. H. Dix, Jr. . . . assistant director of research, Aluminum Company of America, Pittsburgh, Pa., was awarded an Honorary Degree of Doctor of Science from Carnegie Institute of Technology, Pittsburgh, Pa. Dix is known throughout the world for his metallurgical development work on aluminum alloys. He is a member, AFS Pittsburgh Chapter.

J. S. Robbins . . . is the new vice-president of operations, Vulcan Mold and Iron Co., Latrobe, Pa. He has been with Vulcan since 1950.

R. H. Norton . . . has been appointed Northern Ohio representative and **E. J. Fleming** has been appointed New England Representative, Alloy Steel Casting Co., Southampton, Pa.

C. F. Childress Co. . . . Cincinnati, and **C. E. O'Brien Co.,** Dayton, Ohio, have been appointed sales engineers in Ohio for Thermobloc Div., Prat-Daniel Corp., South Norwalk, Conn. Prat-Daniel manufactures industrial heating equipment.

J. R. Hanson . . . has been appointed district sales representative for J. H. France Refractories Co., Snow Shoe, Pa. He will service the New England States and East Central New York, and will handle sales for each of the company's firebrick, high-temperature mortars, refractory castables, plastic firebrick and specialty product divisions.

Dr. Clarence Bremer . . . formerly director of research, has been appointed technical director of Oakite Products, Inc., New York. Bremer will be responsible for the firm's research and product development and technical services laboratories. **Charles**

Rack is head of the technical service laboratory. **W. A. Baltzell,** formerly assistant sales manager, Oakite Products, Inc., New York, has been named industrial-sales manager and will be responsible for the work of the company's 17 divisions and 240 technical service representatives.

M. A. Snyder . . . abrasive engineer in Iowa area since 1951, has been transferred to a similar position in the San Francisco Bay area for Norton Co., Worcester, Mass. **J. H. Saunders** and **W. D. Pollard,** recent graduates of the sales training course, have been assigned to district offices, Pittsburgh, Pa., and St. Louis, respectively, as field engineers.

E. H. King . . . is the new president of Hill & Griffith Co., Cincinnati, Ohio. Formerly vice-president and general manager, he is a member, AFS Cincinnati Chapter.

Frank B. Diana . . . former manager and metallurgist for Frank B. Diana Co., Easton, Conn., is the new president of the firm. Diana is a member, AFS Connecticut Chapter.

Professor Roy W. Schroeder . . . has completed establishing a foundry section and acting as consultant to the College of Agriculture and Mechanic Arts, University of Puerto Rico, Mayaquez. Schroeder, Professor of Mechanical Engineering, University of Illinois, Navy Pier, Chicago, is Vice-Chairman of the AFS Education Division

H. C. Lee . . . vice-president and director, Basic Inc., Cleveland, received the Benjamin G. Lamme Medal, Ohio State University, during 1958 commencement exercises. The gold medal, one of the institution's highest honors, is awarded each year to an alumnus in recognition of "meritorious achievement in engineering or the technical arts."

E. M. Schlesinger . . . has joined the sales staff of Milwaukee Chaplet & Supply Corp., Milwaukee. He was formerly Wisconsin state manager for Black Products Co. He is a member AFS Wisconsin Chapter.

D. B. Sayle . . . of the Cleveland Crane & Engineering Co., Wickliffe, Ohio, has been appointed Northern Ohio sales representative for the company's presses, press brakes and metal-cutting shears.

F. J. Koegler . . . vice-president and director of National Lead Co., New

Heavy Equipment Foundry Reports:

FASTER SET-UP
EASIER SHAKEOUT
of cores made with **RCI COROVIT BINDER**

Big cores, like the one you see here, are commonplace at the Kennedy-Van Saun Manufacturing & Engineering Corp. in Danville, Penn. "With RCI Corovit 7202 binder", says Mr. Harry Lynn, assistant foundry manager, "*cores that required up to 36 man-hours to produce are now finished in 12!*

"No more hand ramming is needed," Mr. Lynn explained, "Corovit sand is simply shovelled into the box, spread out by hand, then struck off.

"In addition, Corovit-based sand mixed with RCI's accelerator cures partially at room temperature. It hardens quickly to support itself, thereby *eliminating up to 75% of arboring, wiring, etc.*

"Another big advantage in using Reichhold Corovit is easy shakeout every time.

"At Kennedy-Van Saun", Mr. Lynn concluded, "we plan to convert almost completely to this core binder, which gives us *the most efficient, fastest method of preparing cores that we have found to date.*"

If *you* would like full information on using this important new *self-curing* core binder, write to RCI for Corovit Bulletin F-11-R.

REICHHOLD CHEMICALS, INC.,
RCI BUILDING, WHITE PLAINS, N.Y.

REICHHOLD
FOUNDRY PRODUCTS
FOUNDREZ—Synthetic Resin Binders
COROVIT—Self-curing Binders
coRClment—Core Oils

Creative Chemistry... Your Partner in Progress RCI

Circle No. 820, Page 7-8

All ladles look pretty much alike . . . but your crews can see and *feel* the Job Engineered advantages of Industrial ladles as soon as they start to pour.

Industrial Job Engineered ladles handle smoothly and easily through the entire pouring routine—tipping, making the pour, straightening and moving on to the next mold. Industrial's special gearing assures precise ladle control at all times . . . and eliminates binding as a result of heat distortion of ladle bowl. One man can easily handle the entire pouring operation. That's why Industrial ladles pay off in lower costs, more efficient operation every time your crews pour a casting.

The ladle shown is for smaller pouring jobs. It is equipped with Bantam Gearing, and offers all the Job Engineered features of Industrial's larger ladles—dependability, ease of operation, accuracy, no binding, one man handling. Send your pouring problems to Industrial Equipment Company—manufacturer of a complete line of standard and custom pouring and handling equipment—Bowls . . . Shanks . . . Bails . . . Tongs. Write today for latest catalog.

Industrial
EQUIPMENT COMPANY
115 OHIO ST., MINSTER, OHIO

Circle No. 821, Page 7-8

York, and general manager of its Doehler-Jarvis Division, has been awarded the honorary degree of Doctor of Commercial Science by the University of Toledo, Toledo, Ohio, for outstanding contributions to industry and education. Koegler, a leader in the die casting industry, has been with the firm for 45 years.

W. H. Buell . . . executive vice-president, Aristo Corp., Detroit, has been awarded an honorary Doctor of Engineering degree by Lawrence Institute of Technology. Buell, an

W. H. Buell

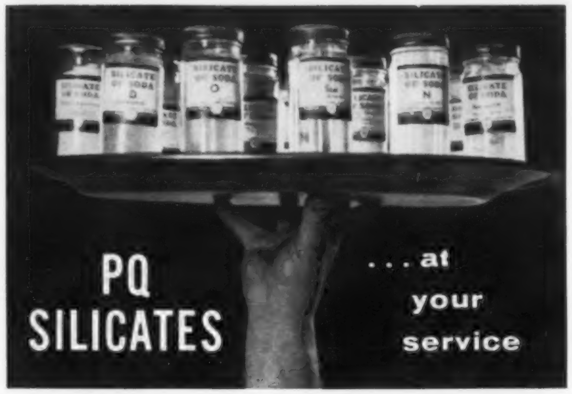
authority in the field of core oil, joined Aristo in 1944 as a research chemist, was promoted to director of research and named to his present position in 1950. He is a member AFS Detroit Chapter, and active in the AFS Sand Division.

Dr. T. J. McLeer . . . has rejoined Cooper Alloy Corp., Hillside, N. J., and will direct the research and development activities of the corporation. McLeer has done considerable work in perfecting the new shell-molding process and holds patents on various phases of the process.

Dr. K. L. Cheng . . . has been appointed associate director of research, Utica Metals Div., Kelsey-Hayes Co., Detroit. Dr. Cheng is active in research in analytical chemistry and his major activities have been the development of special analytical processes and the production of pure elements.

C. R. Lindsay III . . . was elected a director and vice-president, Lindsay Chemical Division of American Potash & Chemical Corp., when the number of directors was increased from nine to ten. The merger of Lindsay Chemical Co. into American Potash & Chemical Corp. recently became effective.

H. W. Schmid . . . vice-president, General Metals Corp., Oakland, Calif.,



Whatever your foundry use for sodium silicate is, the right one for you is found in the PQ line. This covers 40 products (liquids, solids, hydrated and anhydrous powders), $2Na_2O:SiO_2$ to $Na_2O:3.75SiO_2$.

Maintaining quality control in your operations is easier. Both raw materials and finished silicates are carefully checked so that dependable quality is uniform, shipment after shipment.

PQ silicates have been made for a century. Helpful data on silicates and their uses are available in PQ bulletins. Request information on your silicate use.

PHILADELPHIA QUARTZ COMPANY
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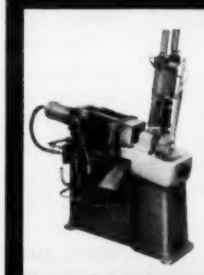
PQ SOLUBLE SILICATES
9 PLANTS • DISTRIBUTORS IN OVER 65 CITIES

Circle No. 822, Page 7-8

Small Parts ?

DIE CAST THEM
IN YOUR OWN PLANT
WITH MINIMUM INVESTMENT
ON

DCMT DIE CASTING MACHINES



Up to 1000 shots per hour! Write for FREE BOOKLET explaining entire process.

DCMT SALES CORP.
Dept. DM 1138
Div. British Industries Corp.
Port Washington, New York

Circle No. 823, Page 7-8

has been assigned the additional responsibility of general manager of the firm's foundry and forge plants in Los Angeles, where he will make his headquarters. **Leo Wansink**, former manager of this plant, has been made assistant to the president.

Sverre Gahr . . . has been promoted from assistant manager to vice-president, Jotul Inc., Oslo, Norway.

M. R. Gallo . . . has been named vice-president, Taccone Corp., North East, Pa.

W. H. Muchnic . . . president, LFM Mfg. Co., of Atchison, Kans.—a subsidiary of Rockwell Mfg. Co.—has been elected vice-president of the parent company. He is a director of the Steel Founders Society of America and former chairman of its Product Development Committee.

M. J. Henley . . . was named vice-president and general manager, Tyler Pipe & Foundry Co., Tyler, Texas. He has a master's degree in metallurgy from Vanderbilt University and during his 12-year association with American Cast Iron Pipe Co., Birmingham, Ala. he was superintendent of foundries. He also worked in the metallurgy department of Texas Foundries, Inc. before coming to Tyler in 1952. In promoting Henley, **Mike Harvey**, plant owner, said: "Henley's probably one of the best-trained men in the foundry industry who is available in the country. Tyler Pipe is operating at peak capacity and the prospects seem good that we will continue this pace during the building season."

R. J. Sloan . . . has been elected president of Crouse-Hinds Co., Syracuse, N. Y. He succeeds **J. R. Tuttle,** who will continue as chairman of the board of directors. Crouse-Hinds is the leading manufacturer of cast electrical conduit fittings. Sloan began his career with the company in 1923 while a student at Cornell University. In 1951 he was elected secretary and director and in 1956 became executive vice-president.

J. M. Crockett . . . assistant to vice-president, gases, Air Reduction Sales Co., Div. Air Reduction Co., Birmingham, Ala., has been appointed manager of the Birmingham District. Crockett replaces **W. L. Poole,** has been named sales consultant for the same district.

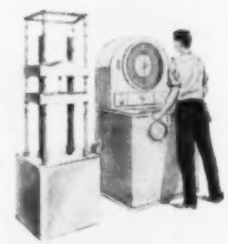
Circle No. 824, Page 7-8

"I always get good ductility using calcium alloys"

Steel foundries employing aluminum deoxidation obtain improved properties by making a supplementary addition of calcium-silicon or calcium-manganese-silicon to the ladle. These calcium alloys help obtain consistently good ductility in the tensile test. Many foundries also report improved fluidity with the calcium additions. Generally 3 to 5 lbs. of alloy per ton insure effective treatment.

ELECTRO METALLURGICAL COMPANY, Division of Union Carbide Corporation, 30 East 42nd St., New York 17, N. Y.

Contact your ELECTROMET representative for further information on getting improved ductility with calcium alloys.



Electromet
FERRO-ALLOYS AND METALS

UNION CARBIDE

The terms "Electromet" and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

Shell Cores for Ford Intake Manifold

by W. R. Moggridge
Ford Motor Co. of Canada
Windsor, Ontario

The shell core is an alternate method of the conventional oil-cereal sand core and those produced by the CO_2 process. The type of core you adopt depends on individual plant operations; the process which will best solve your specific problem both on an economic and quality basis is the one you should use.

In considering the use of shell cores in production of automotive engine intake manifolds, we considered the advantages and disadvantages of shell cores, preparing sand for shell cores and over-all cost.

Advantages of shell cores are:

1) No core ovens are required—this could be a vital factor where space and/or economics dictated this factor to be decisive.

2) Equipment can be located near molding line where cores are used.

3) Little manpower required for production.

4) No moisture picked up during storage.

5) Easily vented—core made either solid or partially hollow.

6) Driers eliminated—core is cured in box.

7) Minimum core box maintenance—shell sand blown at 8-10 psi.

8) Wash eliminated on most cores.

9) Excellent core collapsibility.

10) Sag eliminated, also cracks due to poor driers and handling of green cores.

11) Can be handled without extra care.

12) Minimum of blow defects.

13) Less fins due to core cracks and broken cores.

14) Dimensional accuracy and finish much improved.

15) Cleaning room problems lessened due to good collapsibility and decreased burn-in tendencies.

Intake manifold core assembly with shell cores for gas passage and oil-cereal sand cores for water passage.

16) Less warpage due to cores.

17) Thickness of hollow cores varied as casting design requires.

There are, however, disadvantages:

1) Shell sand costs more per lb of sand than oil-cereal sand.

2) More gas is liberated per lb of sand.

3) Process is not adaptable to bench core making.

Resin-coated sand enables production of higher tensile shells with lower resin contents, eliminating segregation of resin—a previous detriment. There are two coating processes, cold-coating, at room temperature, and hot-coating. In Ford of Canada, we use a liquid resin, room-temperature sand and introduce air at 320 F and 4000 cfm, heated by steam-air heat exchanger.

The coating process you choose should:

1) not produce toxic fumes;

2) use no flammable solvents;

3) require minimum of labor needing no special technical skills, and;

Shell core gives smoother surface for critical gas cross-over in the manifold.

4) the product should have properties reproducible in narrow limits from batch to batch of coated sand.

It is stated that cold-coating is not as desirable for investment box use and it cannot be controlled in as narrow melting point ranges as the hot-coated process. We can and are producing resin-coated sand suitable for shell molds and for shell cores in a controlled process.

Quality improvement required for our automotive engine intake manifold included smoother surface where the intake mixture of gas and air from the carburetor passed to reach the engine cylinders. Another quality consideration was lessened possibility of fins from cracked cores in these passages. Based on a comparison of costs for intake manifold core production by oil-cereal and shell cores; and also quality considerations, the shell core was adopted. Cost data:

Price Data Per Piece

	OIL	SHELL
Material	\$0.0323	\$0.0635
Labor	0.0538	0.0165
Core box and driers	0.0393	0.0230
Total per piece	0.4311	0.1968
Total quantity	\$51.732	\$23.616
Savings \$28.116		

Other tangible savings such as in cleaning the castings and improved finished and quality factors must also be recognized when the shell process is properly evaluated and correctly applied.

■ Based on a talk given at a 1957 AFS Eastern Canada Chapter meeting.

MORE FACTS on all products, literature, and services shown in the advertisements and listed in Products & Processes and in For the Asking can be obtained by using the handy Reader Service cards, page 7-8.

OLIVER SURFACERS

for pattern shops

Planes smooth, accurate patterns at lowest cost

Surfaces stock up to 24" wide, 8" thick. Parts are permanently aligned. Rate of feed controlled by hand dial. Built-in knife grinding and jointing rig. Write for Bulletin No. 299. *Oliver makes 18", 30", 36" Surfacers . . . and all woodworking machines needed for pattern shops.*

OLIVER MACHINERY COMPANY

Grand Rapids 2 Michigan

Circle No. 825, Page 7-8

Save COSTLY MASTER PATTERNS!

GET SCIENTIFIC Pressure Cast MATCH PLATES

We specialize in the casting of precision aluminum pattern duplicates. Plates are poured under pressure in one compact mold to assure accurate filling of ALL detail. Molding is done in plaster for extreme precision and uniformity.

Write for FREE folder.

THE SCIENTIFIC CAST PRODUCTS CORPORATION

"Serving Foundrymen More Than 20 Years"

1390 EAST 40th STREET, CLEVELAND 3, OHIO

2520 WEST LAKE ST., CHICAGO 12, ILLINOIS

Circle No. 826, Page 7-8

EMPIRE*

"THAT GOOD" FOUNDRY COKE

DEBARDELEBEN COAL CORPORATION

2201 First Ave., North Birmingham 3, Ala.

Phone ALpine 1-9135

*Reg. U.S. Pat. Off.

Circle No. 827, Page 7-8

foundry trade news

ALLOY CASTING INSTITUTE . . . New York, emphasized, at the annual meeting, that the foundry industry must take advantage of the present business recession to prepare for the predicted upswing in capital-goods production. Featured at the meeting was the election of new officers—president, P. J. McCulloch, Jr., Electro-Alloys Div., American Brake Shoe Co., Elyria, Ohio; vice-president, J. B. Dear, Duraloy Co., Scottsdale, Pa. New members to the board of directors are E. H. Platz, Jr., Lebanon Steel Foundry, Lebanon, Pa. and J. S. Wooters, General Alloys Co., Boston. E. A. Schoefer, Mineola, N. Y. was re-elected executive vice-president and treasurer.

P. J. McCulloch

High point of the two-day meeting was the session devoted to economic outlook of the alloy casting industry. L. B. Knight, Lester B. Knight & Associates, Inc., Chicago, presented a talk entitled, *Prepare Now For Future Growth of the High Alloy Foundry Industry,* pointing out that the current labor dollar is 35 to 42 per cent of the cost dollar. This amounts to $4500 to $6500 per year per worker, depending upon fringe benefits and other variables. By 1970, Knight stated, this figure will skyrocket to about $10,000.

AMERICAN SOCIETY FOR TESTING MATERIALS . . . elected new national officers at the 61st Annual Meeting, Boston, Mass. K. B. Woods, School of Civil Engineering and, Joint Highway Research Project, Purdue University was elected president. A. A. Bates, Portland Cement Assn., was elected vice-president. F. L. LaQue, Development and Research Div., International Nickel Co., will continue as senior vice-president. Elected for three-year term on board of directors are: P. A. Archibald, Standard Steel Works Div., Baldwin-Lima-Hamilton Corp.; W. L. Fink, Alcoa Research Laboratories; H. M. Hancock, Atlantic Refining Co.; L. A. O'Leary, W. P. Fuller & Co.; A. C. Webber, E. I. DuPont de Nemours & Co., Inc. Certificates of Honorary Membership were presented to four outstanding men: T. S. Fuller, General Electric Co.; H. J. Ball, former professor Lowell Institute of Technology; J. L. McCloud, consulting editor, Metal Progress magazine; and J. G. Morrow, Steel Co. of Canada, Ltd. Honorary members are persons of widely recognized eminence in the field of work covered by the Society or who have rendered especially meritorious service to ASTM.

FOUNDRY EDUCATIONAL FOUNDATION . . . Cleveland, named the first eight recipients of fifty $1500 Wheelabrator Fellowships to be awarded in the next ten years. These winners were selected from a field of 27 candidates by a committee composed of F. X. Bujold, president, F. G. Steinebach, W. B. Bishop, S. C. Massari and C. F. Walton.

Nicholas Baloff, El Cerrito, Calif., 1958 graduate of the University of California, will continue his studies there in the field of industrial engineering. R. V. Barone, Belmont, Mass., 1958 graduate of Massachusetts Institute of Technology, will continue his graduate work in the

Up in the air over a consistent melt quality?

Junior's out to prove he's handy at hooky! He's hidden behind the homestead—but those buoyant bubbles are making the rounds! This is one peace pipe that's going to open hostilities!

THEN IT'S NO TIME FOR PIPE DREAMS . . . not when uniformity of quality counts! That's when you turn to Keokuk Silvery Pig Iron, the superior form of silicon introduction—famous for its unvarying uniformity of results. Handle by magnet, furnace-charge by weight, or count the pigs for equal accuracy. For Aluminum producing, it's Keokuk Silicon Metal. Nothing finer!

Keokuk Electro-Metals Company Keokuk, Iowa;
Wenatchee Division, Wenatchee, Washington

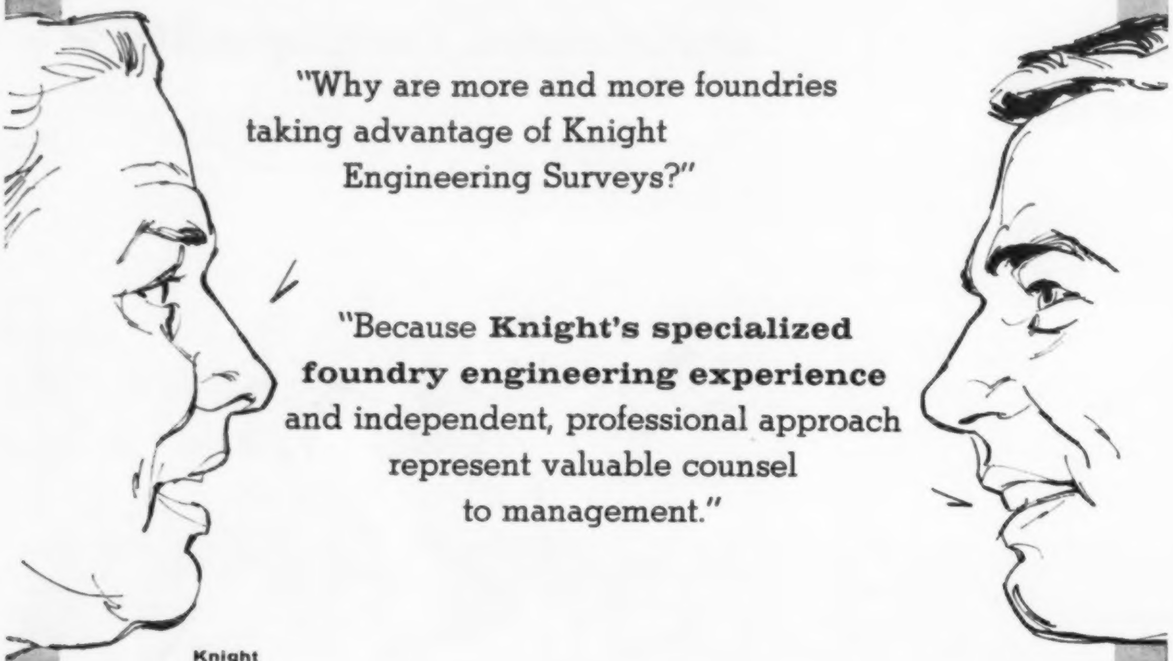
KEOKUK SILVERY PIG IRON
SILICON METAL—OTHER FERROALLOYS

When you think of SILICON think of KEOKUK!

SALES AGENT: MILLER AND COMPANY
332 S. Michigan Avenue, Chicago 4, Illinois
3504 Carew Tower, Cincinnati 2, Ohio
8230 Forsyth Blvd., St. Louis 24, Missouri

Keokuk Silvery Pig—the superior form of silicon introduction—is available in 60 and 30 lb. pigs and 12½ lb. piglets in standard analysis or alloyed to your specifications. Silicon metal and ferrosilicon are supplied in standard sizes and analyses.

Circle No. 829, Page 7-8



Knight services include:

Foundry Engineering
Architectural Engineering
Construction Management
Organization
Management
Industrial Engineering
Wage Incentives
Cost Control
Standard Costs
Flexible Budgeting
Production Control
Modernization
Mechanization
Methods
Materials Handling
Automation
Survey of Facilities
Marketing

Knight Engineers are well qualified to analyze foundry operations and recommend methods, processes and machines. The Knight organization has successfully completed more than 350 assignments in every type and size of foundry. Surveys are made impartially, considering only facts and economical solutions—not influenced by other responsibilities to management or an interest in equipment sales. Call us for a preliminary discussion of how a Knight Foundry Survey can help you.

EVIDENCE OF EXPERIENCE

Lester B. Knight & Associates, Inc.

Management, Industrial and Plant Engineers

Member of the Association of Consulting Management Engineers, Inc.
549 W. Randolph St., Chicago 6, Ill.
917 Fifteenth St., N.W., Washington, D. C.
New York Office—Lester B. Knight & Associates, 375 Fifth Ave., New York City 16
Knight Engineering Establishment (Vaduz), Zurich Branch, Bahnhofstrasse 17, Zurich, Switzerland

Circle No. 830, Page 7-8

gical engineering. H. D. Bradshaw, Hampton, Va., a 1957 graduate of University of Alabama, will continue there in the field of metallurgical engineering.

C. F. Knight, Winnetka, Ill., a 1958 graduate of Cornell University, will return there to do graduate work in business administration. P. J. Lady, Kenton, Ohio, University of Cincinnati 1958 graduate, has chosen Harvard Business School for graduate work in marketing.

W. F. Shaw, Kohler, Wis., and J. R. Widmoyer of LaCrosse, Wis., are both graduates of the University of Wisconsin where they will return for advanced work in metallurgical engineering.

R. J. Warrick, Homer, Mich., 1958 Michigan State University graduate, will continue his advanced work at M.S.U. in metallurgy.

The Wheelabrator Foundation in cooperation with the F.E.F. established the Wheelabrator Foundry Educational program earlier this year to celebrate the 50th anniversary of Wheelabrator Corp., Mishawaka, Ind.

British Investment Casters Technical Assn. . . . has been formed serving the foundry industry using expendable pattern techniques for the production of industrial metal castings. Objectives and scope of the new organization are entirely devoted to technical aspects of investment casting and will include preparation of specifications for materials and testing procedures, improvement of production techniques, expansion of application of investment castings and general exchange of technical information within the industry. The inaugural meeting was held in London, England June 11 and was attended by representatives of 25 companies. The address of the new association will be 5, East Bank Road, Sheffield 2.

Foundry Equipment Mfg. Assn., . . . Washington, D. C., announced R. L. Gilmore as guest speaker for the 1958 Annual Meeting. Gilmore, president, Superior Steel & Malleable Castings Co., has spent his career in the foundry industry starting as a coremaker over 30 years ago. He will speak on "Meeting Today's Requirements for Quality Foundry Products."

Last year's Panel Presentation was so successful that it will be repeated this year and Dick Brackett has been drafted to act as moderator again this year. His panel of four experts will discuss the broad theme of marketing foundry equipment. Speakers and their subjects are: Gordon Seavoy, Whiting Corp. "Marketing Costs",

Philip Bauer, Allis-Chalmers Mfg. Co., "Effects of Foreign Competition"; George Pope, *Foundry*, "Analysis of the Foundry Industry"; and David Davidson, Link-Belt Co., "Technique of Forecasting".

AMERICAN SOCIETY OF MECHANICAL ENGINEERS . . . were told at their Semi-Annual Meeting, New York, in June, that automotive gas turbines will replace conventional gasoline and diesel engines within the next 50 years. A. T. Bowden and W. Hryniszak, C. A. Parsons & Co., Ltd., Newcastle-on-Tyne, England, presented this theory at the semi-annual meeting and confirmed earlier predictions that it would be possible to develop gas-turbine engines that will fit into space now occupied by conventional engines.

Symington-Gould Corp. . . . Depew, N. Y. and Wayne Pump Co., Salisbury, Md. effected a merger approved by directors and stockholders of the two companies at meetings held in March. The name of the new company is now Symington Wayne Corp.

C. J. Symington is Honorary Chairman Board of Directors; Hynes Sparks, former Symington president, is now Chairman of the Board; and W. H. Bateman, former president of Wayne, is president.

Archer-Daniels-Midland Co. . . . Cleveland, announced three new refractory washes rounding out the ADM-Federal line, providing washes for every process: shell, CO_2, air-set or oil-bonded cores and molds. These are ideal for application by brushing, dipping, spraying or swabbing.

General Motors . . . has developed and tested three aluminum V-8 automobile engines. Research on aluminum engines began six years ago; they are hand-built not production models. They weigh 30 per cent less than conventional cast-iron engines. GM's goal is to build them at less cost than cast iron engines. Over-all objective, according to C. A. Chayne, vice-president in charge of engineering staff and Dr. L. R. Hafstad, vice-president in charge of research, is to develop lighter weight engines with better economy and with better performance.

Aluminum industrial center . . . being formed in Massena, N. Y. by the expansion of Reynolds Metal Co. plant to be completed this year; Aluminum Co. of America expansion and a Chevrolet Div. of General Motors foundry. The Reynolds Aluminum

VOLCLAY BENTONITE
NEWSLETTER No. 57
REPORTING NEWS AND DEVELOPMENTS IN THE FOUNDRY USE OF BENTONITE

Flowability
Ramability
WHICH IS IT?

In general, few additions to molding sand increase flowability or ramability—**whichever it is called.**

"This sand sure flows since we substituted Panther Creek as the bond."

A silica base sand with no additives, including water, **flows best when dried to 0% moisture content.**

When dry binders are added to the sand before the water, **the sand mixture still flows,** maybe not as well, **but it is free flowing.**

Next, the water is added and **the mixture begins to stiffen.** The degree of stiffening can be measured in several ways, **one is the degree of flow—or ramability.**

The property of the sand mixture that induces flow in any direction under pressure **is defined as "flowability."** It could be called "ramability", "plasticity", or the "stiffening effect".

It is generally agreed that southern bentonite, **Panther Creek, bonded sand mixtures have the best degree of flowability.**

However, simply adding southern bentonite to a mixture **may lessen flow, not increase it.** Southern bentonite **must be substituted for a bond in the mixture—** something must be removed—not added.

A flowable sand decreases the work that is applied, **less energy is required** to place the mixture securely against the pattern—**ramability is increased.**

Panther Creek bonded sand allows less work, less force to move the mixture. For that reason all foundries are measuring this labor saving property.

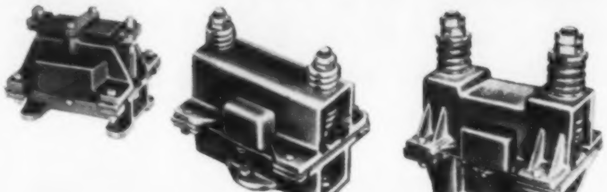
Are you measuring yours?

Write for BN-7, "Stork News", 202 PC, Data No. 244, "Economy in the Foundry"

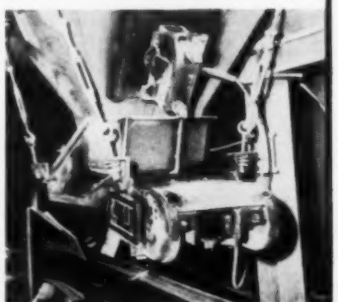
AMERICAN COLLOID COMPANY
SKOKIE, ILLINOIS • PRODUCERS OF VOLCLAY AND PANTHER CREEK BENTONITE

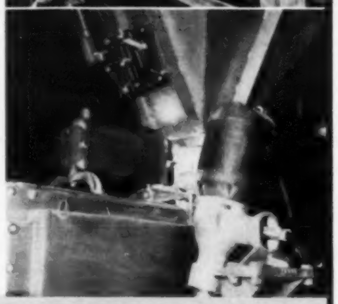
Circle No. 831, Page 7-8

SYNTRON Pulsating Magnet
BIN VIBRATORS



KEEP MATERIALS FLOWING FREELY — ELIMINATE ARCHING AND PLUGGING OF BINS AND HOPPERS





—designed to keep materials flowing freely through bins, hoppers and chutes efficiently, effectively and economically.
—help processing equipment operate at full capacity by eliminating slow downs or shut downs due to arching and plugging of materials.
—SYNTRON Bin Vibrators set up waves of powerful, high speed, instantly controllable 3600 vibrations per minute that move the most stubborn materials.

SYNTRON engineered Bin Vibrators offer these advantages for low cost operation —versatility, dependability, easy installation and inexpensive maintenance.

SYNTRON Bin Vibrators are built in a wide range of types to fill every need from a cubic foot hopper to large bins and bunkers.

Available in electromagnetic, pneumatic or hydraulic powered units.

Solve that troublesome bin problem with SYNTRON Bin Vibrators.

ME1580

Syntron can help you with problems involving . . .

Vibrators (bins, hoppers, chutes)	Rectifiers (Silicon and Selenium)
Vibratory Feeders	a-c to d-c Selenium Rectifier Units
Vibratory Screens	Electric Heating Panels
Shaker Conveyors	Electric Heating Elements
Vibratory Elevator Feeders	Sinuated Wires
Weigh Feeders	Shaft Seals
Packers and Jolters	Electric Hammers
Hopper Feeders	Concrete Vibrators
Lapping Machines	Paper Joggers

Our representatives will be glad to work with you in selecting the proper equipment for your operation.

Call your nearest Syntron representative

For more information write for complete catalog . . . Free

SYNTRON COMPANY
545 Lexington Avenue Homer City, Penna.

Circle No. 817, Page 7-8

Digest reports that Reynolds' new plant will have a capacity of 100,000 tons a year. Alcoa conducts extensive fabricating operations near Massena and is expanding production to a potential 149,000 tons per year. Chevrolet Div. expects the new 35,000-ton foundry to be ready for operation by the time Reynolds is ready to start pouring the hot metal which will be converted into castings and products for automotive use.

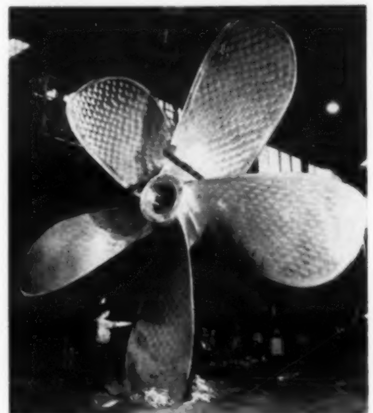
Borden Chemical Co. . . . has recently completed a foundry laboratory in Bainbridge, N. Y. Howard Hoyt, a shell-mold resins authority, will be in charge of the resins and sands evaluation program and will supervise further development of a new sand-coating technique using liquid resins. The laboratory is fully equipped for development, testing and quality control work with sand and sand cores and has a tensile testing machine which analyzes the core's degree of cure and checks the core binder strength.

Core curing at Borden Laboratories is shown by technical service manager, J. A. Meima, placing a core into the dielectric oven for curing. The sand laboratory is equipped to cure cores both dielectrically and by conventional ovens.

National Malleable & Steel Castings Co. . . . Cleveland, announced the closing of it's Indianapolis plant. Company officials said re-opening will depend on business conditions and production requirements. It is expected to be out of production for at least a year. The plant employed 450 personnel and is one of the company's eight plants.

Eberhard Mfg. Co. . . . Div. Eastern Malleable Iron Co., Cleveland, laid off 200 of its 400 employees when it closed its foundry recently. D. W. Walker, manager, said: "We'll continue production of truck and bus hardware." Eberhard is one of Cleveland's oldest companies, starting in 1874. In recent years it became an almost completely automatic foundry.

South Gate Aluminm & Magnesium Co. . . . South Gate, Cal., has developed a controlled chemistry version of casting magnesium-zinc-zirconium alloy to increase mechanical properties and ductility. This alloy "South Gate-Excell-51" meets Federal specifications QQ-M-56 and has been successfully poured in complex design configurations, providing more favorable strength-weight ratio. This enables design engineers to use the more economical cast construction in place of heavier sheet metal fabrication normally associated with aircraft and missile design.



Big propellers measuring over 24 ft 8 in. and weighing over 38 tons each when finished—machine will be used on giant super-tankers now under construction in Japan by Welding Shipyard Div., National Bulk Carriers, Inc. The propellers are now being manufactured at Eddystone Div., Baldwin-Lima-Hamilton Corp., Eddystone, Pa. The new tankers—940 feet long with a 135-ft beam and 104,500 dead weight tons—will be the largest cargo ships ever to ply the seven seas. Equipped with the B-L-H propellers, these vessels will develop 27,500 shaft horsepower at load speeds over 15 knots.

Sterling Steel Casting Co. . . . East St. Louis, Ill., announced the election of J. O. Shive, president; W. J. Shive, vice-president, R. O. Shive, secretary; and C. R. Shive, treasurer.

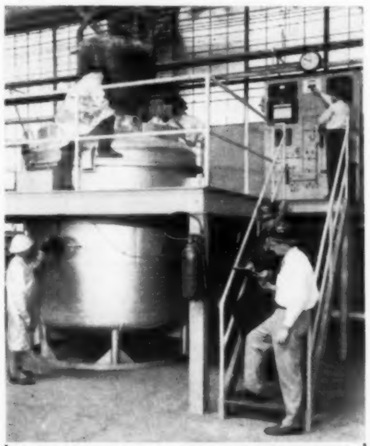
American Smelting & Refining Co. . . . New York, has just completed a major addition to its Corpus Christi refinery which will handle production of the entire range of zinc alloys sold by the firm's Federated Metals Div. Previously special high-grade zinc had been shipped to their other plants to be alloyed. Because of economies effected by this handling Asarco has reduced its zinc die-cast prices.

Allis-Chalmers Mfg. Co. . . . Milwaukee, announced the re-hiring of ap-

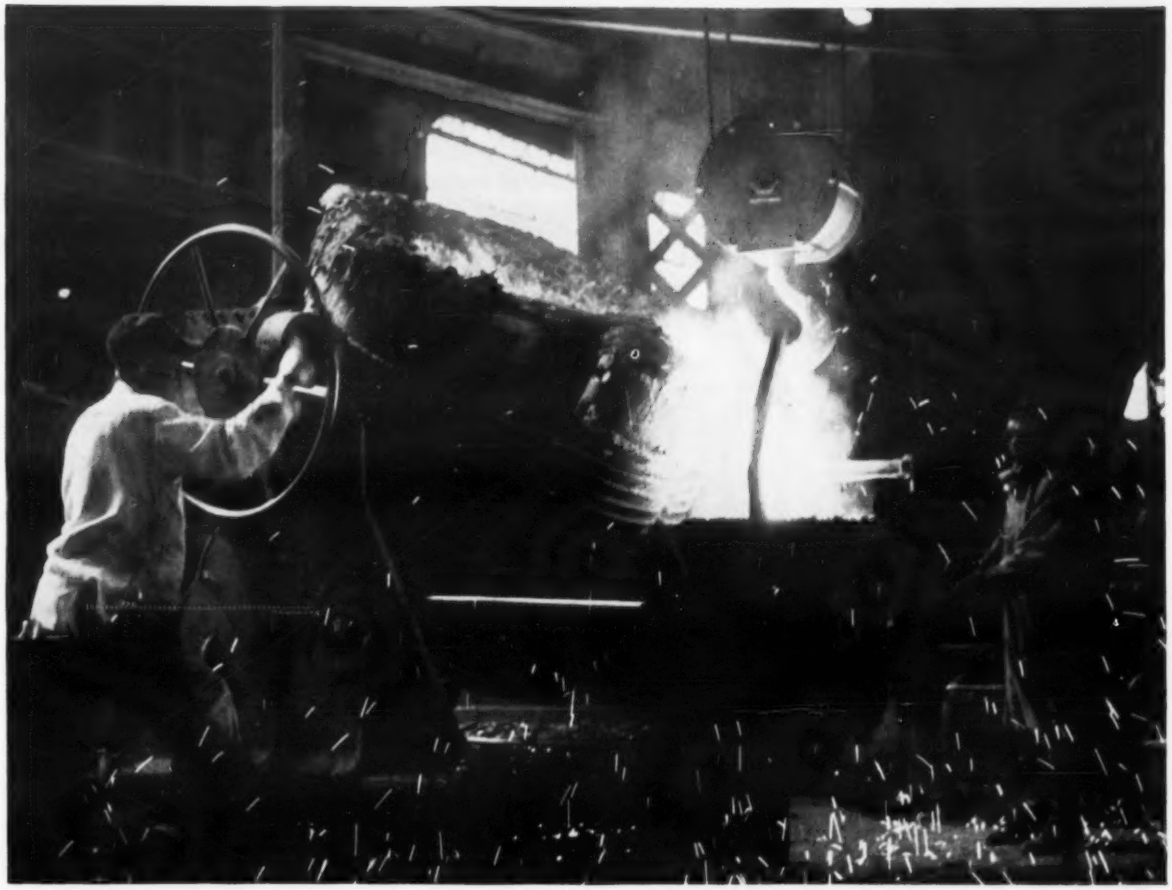
proximately 700 employees. The increase in jobs is possible because of the reduction in stock parts and completed construction machinery. The rate of employment and production attained this month may be continued —if not expanded.

National Cylinder Gas Co. . . . Chicago, directors voted to change name of company to *Chemetron Corp.* C. J. Haines, president, made the announcement, saying, "The 24-year old National Cylinder Gas name was satisfactory while the firm produced only industrial gases and equipment using industrial gases but addition, through the years, of many new product lines and services made it too restrictive."

Chicago Hardware Foundry Co . . . North Chicago, Ill., announced the continued expansion of production facilities for non-ferrous castings with completion of a $100,000 building for receiving, casting, finishing and shipping of non-ferrous metals. This second stage doubles production facilities, the first stage being an all-new aluminum molding and melting building. Its objective for CHF Non-Ferrous Division is a completely new, integrated unit for processing non-ferrous castings from receipt of ingot to shipment of finished product.



Effect of vacuum degassing technique in removing impurities in molten metal is examined by technicians and engineers at the new $750,000 Applied Research and Development Laboratory of General Electric Company's Foundry Department. The chamber, first and largest of its type in the foundry industry, is just one of the pieces of apparatus being utilized by the laboratory to determine more efficient methods of foundry technology, especially in the application of high temperature metals and alloys.



Every inch a ladle . . .

"Teapot spout" pours clean without skimming!

A Chicago foundry distributes clean molten metal every time with this *Whiting Teapot Spout Ladle*. Easy to operate, there's no skimming required because floating slag forms a crust to keep heat *in* and temperature right for bottom pour. Easy to maintain, the simple spout arrangement is independent of bowl, can be relined without disturbing bowl proper!

Whiting Ladles of all types and sizes are designed to speed output, minimize labor and improve quality of foundry castings. Built to withstand the rigors of year in, year out service, they feature steel spouts, riveted or welded heads and specially designed bowl reinforcement.

SEND FOR 36 PAGE BULLETIN FY-163-R

. . . it details and describes *Whiting Ladles*, shows how accurate pouring, greater safety, easier control and longer life are built into eighteen different types! *Whiting Corporation, 15628 Lathrop Avenue, Harvey, Ill.*

Member of the Foundry Equipment Manufacturers Association.

87 OF AMERICA'S "FIRST HUNDRED" CORPORATIONS ARE WHITING CUSTOMERS

WHITING FOUNDRY EQUIPMENT

MANUFACTURERS OF CRANES; TRAMBEAM HANDLING SYSTEMS; TRACKMOBILES; FOUNDRY, RAILROAD AND CHEMICAL PROCESSING EQUIPMENT

Circle No. 833, Page 7-8

here's how . . . General Electric Co.'s Foundry Department Elmira Foundries use electrified paint to coat castings and save money. Castings are placed on a conveyor that loops around a disc. The disc is charged with high voltage current. Paint is fed onto the surface of the disc as it rotates. Paint is hurled off the disc in tiny, electrically-charged droplets. The charged drops are grounded on the castings. General Electric expects to save $25,000 annually in the cost of paint alone since practically all of the paint is attracted to the castings and there is little waste.

"In spite of all precautions a foundry will generate scrap; but the fact still remains that making scrap is actually money thrown away."—NONFERROUS SCRAP CONTROL

"Reducing the nonferrous foundry's scrap percentage is as important as upholding the level of production output per worker", says the well-known foundry engineer quoted above.

One method of reducing scrap production, he suggests, is in a closer control of molten metal temperatures.

This is the field in which Marshall Enclosed-Tip Thermocouples can aid the foundryman. These Thermocouples report temperatures from within the melt reliably. Convenient to use, they withstand repeated immersions. Tip can be replaced quickly, making the instrument "good as new".

Marshall Thermocouples take temperatures of brass, aluminum and magnesium. Send for further data.

L. H. MARSHALL CO.
270 W. Lane Ave.
Columbus 2, Ohio

Circle No. 834, Page 7-8

Build an idea file for plant improvements. Reader Service Cards, page 7-8 will bring more information . . .

for the asking

Steel castings operations . . . depicted in booklet, 18 pp, covering manufacturing steps in producing stainless, carbon, and alloy steel castings. *Empire Steel Castings, Inc.*
Circle No. 661, Page 7-8

Machining gray and nodular iron . . . 22-p booklet, covers machining properties of cast iron. Performance data supplied on various types of grinders. *Hamilton Foundry & Machine Co.*
Circle No. 662, Page 7-8

Machining manual . . . 22 pp, contains guide for machine feeds and speed, and quantity-weight slide-rule calculator. *Kaiser Aluminum & Chemical Sales, Inc.*
Circle No. 663, Page 7-8

CO_2 shell molding . . . development reviewed. Advantages of being non-inflamable and non-gas forming are described. *Philadelphia Quartz Co.*
Circle No. 664, Page 7-8

Investment-cast-metals . . . chart offers reference material on ferrous base and non-ferrous alloys. *Alloy Precision Casting Co.*
Circle No. 665, Page 7-8

Steel casting brochure . . . lists three basic requirements for successful product design. *Steel Founders' Society of America.*
Circle No. 666, Page 7-8

Pinholes or inclusions . . . is the title of newsletter which discusses inspection, causes, inclusions, improperly cleaned ladles and other factors causing these faults. *American Colloid Co.*
Circle No. 667, Page 7-8

Stainless steel fabrication . . . methods and practices are covered in detail in a 386-p book containing charts and graphs. *Allegheny Ludlow Steel Corp.*
Circle No. 668, Page 7-8

Air setting binders . . . technical article, lists the advantages and disadvantages, equipment, temperature, waiting time, etc. *Archer-Daniels-Midland Co.*
Circle No. 669, Page 7-8

Welders' vest-pocket guide . . . 60 pp, describes and illustrates four essentials of proper welding procedures, types of joints and welding positions. *Hobart Bros. Co.*
Circle No. 670, Page 7-8

Investment (lost wax) process . . . evaluated in monthly newsletter. Successful use in metalcastings analyzed. *The Metal Castings Advisor.*
Circle No. 671, Page 7-8

Collective bargaining . . . do's and dont's summarized in 10-p article. *National Foundry Association.*
Circle No. 672, Page 7-8

Foundry practice . . . bulletin includes four technical articles dealing with: aluminum rotor castings, copper-tin alloys, pressure and exothermic feeding of iron castings, and heat treatment. *Foundry Services, Inc.*
Circle No. 673, Page 7-8

Rare earths . . . and their metallurgical applications, both ferrous and non-ferrous, are discussed in abstract form in manual. *Davison Chemical Co.*
Circle No. 674, Page 7-8

Carbon sand . . . a new molding material composed of particles of hard carbon is described and compared with other molding sands in 16-p booklet. *J. S. McCormick Co.*
Circle No. 675, Page 7-8

Birth of gray iron castings . . . related in technical book. Reviews the essential role of gfay iron in modern manufacturing. *Pittsburgh Coke & Chemical Co.*
Circle No. 676, Page 7-8

Reference catalog . . . 16-pp, gives alphabetical listing of over 1500 products including alloys and metals, carbon products, chemical products and others. *Union Carbide Corp.*
Circle No. 677, Page 7-8

Gamma radiography . . . of castings detailed in 18-p manual covering cost, versatility, safety, portability, maintenance, and exposure time. *Nuclear Systems Div., Budd Co.*
Circle No. 678, Page 7-8

Technical data . . . catalog free. Revised listing of pocket-size books selling for $1.25 covering every field of engineering. *Lefax Publishers.*
Circle No. 679, Page 7-8

Cast jackets . . . said to instantly assume exact shape of mold upon application. End and sides may be purchased separately. *Hines Flask Co.*
Circle No. 680, Page 7-8

Mullite refractory . . . material fully explained in brochure. Claims outstanding resistance to chemical attack and erosion by flux-laden gases. *Chas. Taylor Sons Co.*
Circle No. 681, Page 7-8

Air pollution control . . . and ventilation equipment pictured in 8-p bulletin which gives details of many items. *Claude B. Schneible Co.*
Circle No. 682, Page 7-8

Self-dumping hopper . . . of wet or dry, hot or cold, and bulk materials shown in brochure. *Roura Iron Works, Inc.*
Circle No. 683, Page 7-8

Freight yard . . . handling facilitated with convertible road and rail truck. Featured in bulletin. *Whiting Corp.*
Circle No. 684, Page 7-8

Coated abrasives . . . fabrication and use discussed in large, 25-p booklet. *Behr-Manning Co.*
Circle No. 685, Page 7-8

Zircon wash . . . reported to reduce metal penetration and produce cleaner castings Folder available. *G. E. Smith, Inc.*
Circle No. 686, Page 7-8

Foundry alloys . . . ferrochromium, ferrosilicon, ferrovanadium; special and briquetted; covered in brochure. *Vanadium Corp. of America.*
Circle No. 687, Page 7-8

Slip clutches . . . and couplings on industrial machinery described and uses depicted in bulletin. *Hilliard Corp.*
Circle No. 688, Page 7-8

Stimulating sales . . . through a planned program of product publicity is subject of folder. *Healy Advertising Agency.*
Circle No. 689, Page 7-8

Automation . . . of materials handling outlined in a case history bulletin describing the metal-working plant operations *Lewis-Shepard Products, Inc.*
Circle No. 690, Page 7-8

Wire rope . . . handbook, 36 p, available on selection, use and care of wire rope. *Wire Rope Corp. of America.*
Circle No. 691, Page 7-8

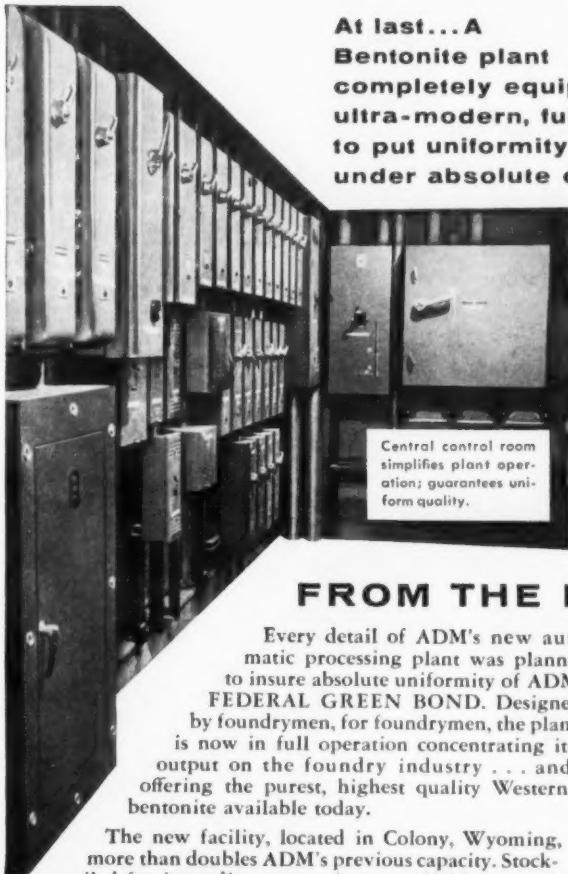
CO_2 process . . . information sheet describes the process for producing cores and molds. Presents foundry innovations which have resulted since process first proved a success. *J. David Johnson Co.*
Circle No. 692, Page 7-8

Cupola water cooling . . . explained and illustrated with line drawings and photos of foundry applications in bulletin. *Modern Equipment Co.*
Circle No. 693, Page 7-8

Technical data . . . catalog free. Revised listing of pocket-size books selling for $1.25 covering engineering field. *Lefax Publishers.*
Circle No. 694, Page 7-8

Fork lift . . . truck which moves sideways in addition to conventional operation described in bulletin. *Raymond Corp.*
Circle No. 757, Page 7-8

At last . . . A Bentonite plant completely equipped, ultra-modern, fully automatic to put uniformity under absolute control with . . .



Central control room simplifies plant operation; guarantees uniform quality.

"AUTOMATED" PROCESSING

FROM THE MINE TO YOUR PLANT

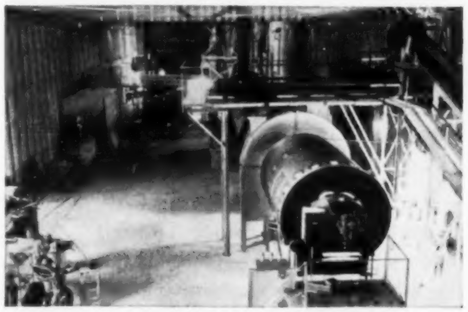
Every detail of ADM's new automatic processing plant was planned to insure absolute uniformity of ADM-FEDERAL GREEN BOND. Designed by foundrymen, for foundrymen, the plant is now in full operation concentrating its output on the foundry industry . . . and offering the purest, highest quality Western bentonite available today.

The new facility, located in Colony, Wyoming, more than doubles ADM's previous capacity. Stockpiled for immediate processing are 150,000 tons of virgin clay, with millions of tons drill-tested for purity and ready for mining.

Every chance of human error has been eliminated by the latest production control devices. All measuring and weighing is done by instruments, dryer heat is electronically controlled, material is handled by the most modern pneumatic and belt conveyors, and packaging is completely automatic.

These are a few reasons why ADM-FEDERAL GREEN BOND Bentonite will provide more casting benefits per dollar than any binder of its kind.

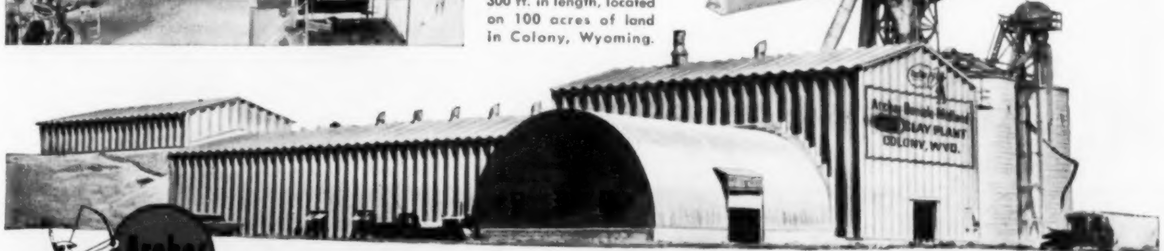
The Colony operation is further evidence of ADM's determination to provide the foundry industry with intelligent solutions to their casting problems. Talk to an ADM field service representative today and you'll see these attitudes reflected. Why not visit our new plant soon?



Interior of processing plant illustrates in-line arrangement of equipment. Dryer is shown in foreground.

The new bag design for ADM-FEDERAL GREEN BOND Bentonite is now labeled with the familiar Archer trademark, your guarantee of quality.*

*Two first-place awards in the American Oil Chemists Society's Smalley Check Sample Competition have been won by ADM Control Laboratories.



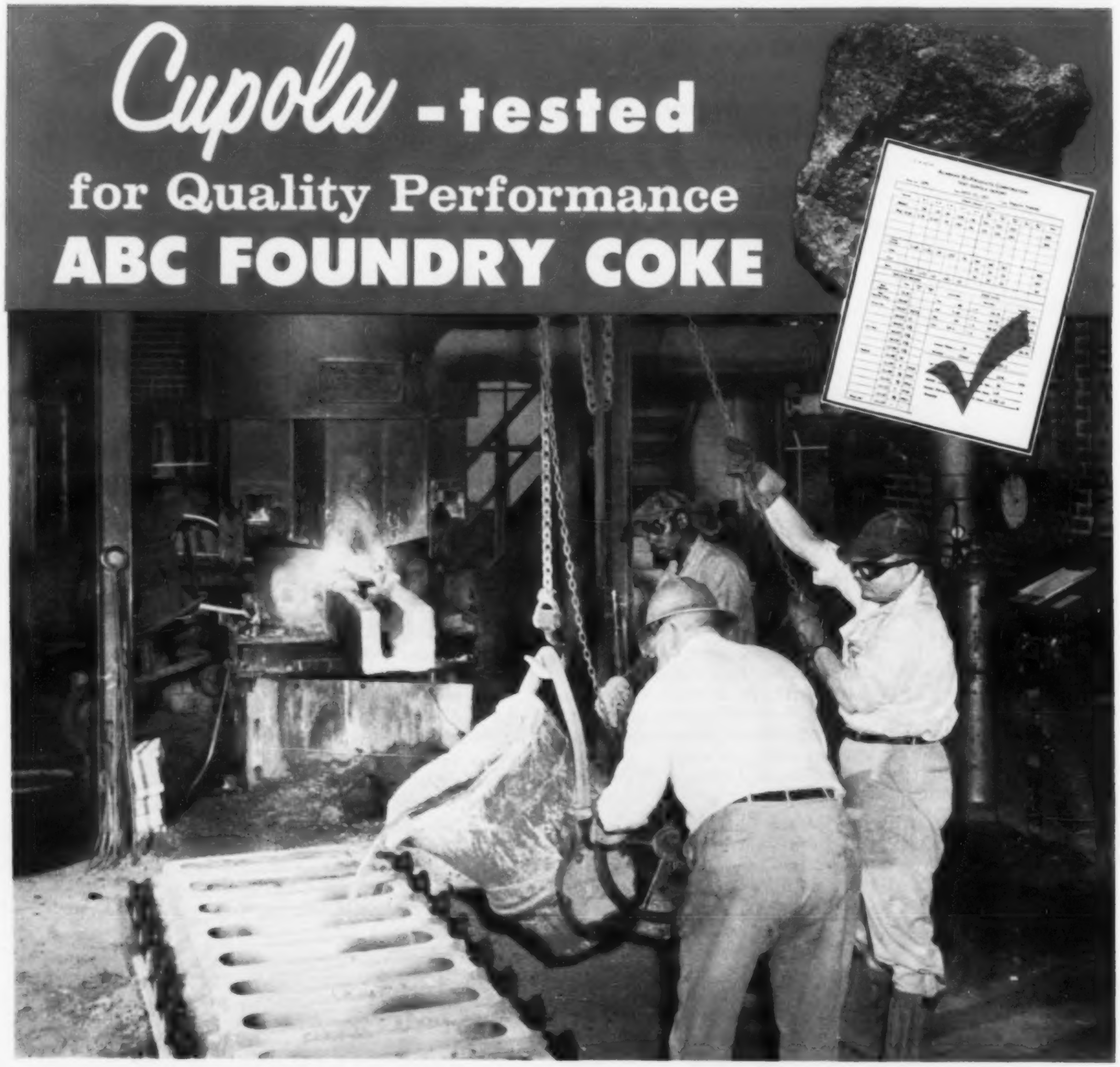
Archer-Daniels-Midland, Clay Plant, new Bentonite production layout, 300 ft. in length, located on 100 acres of land in Colony, Wyoming.

Archer Daniels Midland company

FEDERAL FOUNDRY SUPPLY DIVISION

2191 West 110th Street • Cleveland 2, Ohio

Circle No. 835, Page 7-8



Control-testing of ABC foundry coke for carbon pick-up and melting temperature plays an important part in maintaining that consistent uniformity in quality for which it has long been recognized in the foundry trade.

ABC pioneered this method of pre-checking performance of its coke. Since 1944 it has operated a production size No. 2 Whiting cupola under supervision of its Research Department and service engineers. No laboratory tests can give comparable results in accurately determining coke quality and performance. Results of tests are kept by ABC and furnished customers on request.

ABC

Your inquiries are invited.

ALABAMA BY-PRODUCTS CORPORATION

General Sales Office: First National Building, Birmingham, Alabama

Sales Agents GREAT LAKES FOUNDRY SAND COMPANY, Detroit; ST. LOUIS COKE & FOUNDRY SUPPLY CO., St. Louis; THE RANSON AND ORR COMPANY, Cincinnati; KERCHNER, MARSHALL AND COMPANY, Pittsburgh; BALFOUR, GUTHRIE & COMPANY, LTD., San Francisco; ATWILL COKE AND COAL COMPANY, Chicago.

Circle No. 836, Page 7-8

Radiation safeguards . . . in form of film packets worn by workers involved in handling or proximity to radioactive materials described in 14-p booklet. *E. I. Du-Pont de Nemours & Co.*
Circle No. 695, Page 7-8

Temperature controls . . . local mounted and remote bulb type, described in 8-p catalog. *United Electric Controls Co.*
Circle No. 696, Page 7-8

Muller type mixers . . . for conditioning foundry sand and other materials described and explained in detail in 40-p, colorful catalog. *Clearfield Machine Co.*
Circle No. 697, Page 7-8

Industrial blowers . . . and exhausters described as to operating data, specifications and performance in 6-p bulletin. *Miehle-Dexter Div.*
Circle No. 698, Page 7-8

Beryllium metal . . . properties illustrated with graphs and charts in booklet. *Brush Beryllium Co.*
Circle No. 699, Page 7-8

Electric furnace maintenance . . . portrayed in picture of action in the foundry. Suitable for framing. *Great Lakes Carbon Co.*
Circle No. 700, Page 7-8

Patterns . . . wood, plastic and metal, development and production described and illustrated in 12-p booklet. *The Motor Patterns Co.*
Circle No. 701, Page 7-8

Index to 1957 issues . . . of Modern Castings available. Valuable cross-references by subject, author and company.
Circle No. 702, Page 7-8

Pinholes or inclusions . . . newsletter discusses inspection, causes, inclusions, improperly cleaned ladles and other factors causing faults. *American Colloid Co.*
Circle No. 703, Page 7-8

Collective bargaining . . . do's and don't's summarized in 10-p article stressing equalization of bargaining facilities by labor and management. *National Foundry Association.*
Circle No. 704, Page 7-8

Photodrawings . . . publication describes the use of photographs to convey engineering-drawing information. *Eastman Kodak Co.*
Circle No. 705, Page 7-8

Ductile iron . . . applications in foundry shown pictorially in 12-p bulletin. *T. B. Wood's Sons Co.*
Circle No. 706, Page 7-8

Drafting room . . . short cuts provided by reproduction materials outlined in booklet. *Eastman Kodak Co.*
Circle No. 707, Page 7-8

Tractor shovel . . . four-wheel drive, rear-wheel power-steering discussed in 12-p catalog. *J. I. Case Co.*
Circle No. 708, Page 7-8

Gravity conveyor . . . applications depicted in brochure. *Rapids-Standard Co.*
Circle No. 736, Page 7-8

Centrifugal ventilators . . . for roof installation covered in bulletin including many line drawings pointing out features. *ILG Electric Ventilating Co.*
Circle No. 709, Page 7-8

Heavy-duty floor materials . . . presented in 4-p booklet. Explains application of emery aggregates, bricks, bonds and cures. *Walter Maguire Co.*
Circle No. 710, Page 7-8

Investment castings . . . designing featured in 8-p brochure. Covering such factors as fillets, holes, threads, wall thicknesses and tolerances. *Casting Engineers, Inc.*
Circle No. 711, Page 7-8

Heating equipment . . . pictorially displayed in 6-p bulletin showing many gas, electric and induction-heating units. *General Electric Co.*
Circle No. 712, Page 7-8

Powder-lancing . . . process described and advantages listed in brochure. Ten case histories outlined. *Linde Co.*
Circle No. 713, Page 7-8

Compressed air-cutting . . . equipment for finishing castings pictured in operation in brochure. *Hobart Brothers Co.*
Circle No. 714, Page 7-8

Stainless-steel fabrication . . . operations such as machining, welding and heat treating of cast-corrosion resistant and heat-resistant high alloys detailed in 6-p folder. *Alloy Casting Institute.*
Circle No. 715, Page 7-8

Tractor shovel . . . portrayed in two-color illustrations included in brochure. Construction and operating features pointed out. *Allis Chalmers Mfg. Co.*
Circle No. 716, Page 7-8

Materials handling versatility . . . graphically portrayed in booklet demonstrating utility of interchangeable front-end attachments of tractor shovel. *Frank G. Hough Co.*
Circle No. 717, Page 7-8

Materials-handling conveyors . . . catalog describes complete line of heavy-duty conveyors for moving scrap, stampings, castings and heavy parts. *May-Fran Engineering, Inc.*
Circle No. 718, Page 7-8

Lift truck purchasing . . . factors to be considered listed in booklet. *Hyster Co.*
Circle No. 719, Page 7-8

Fork-lift trucks . . . discussed in 16-p catalog covering engineering, design, construction and operating features. *Allis-Chalmers Mfg. Co.*
Circle No. 720, Page 7-8

Welding wire . . . pocket guide, 84 pp reportedly has answers to almost every question that can be asked about welding wire for use with gas-shielded metal-arc process. *Air Reduction Sales Co.*
Circle No. 721, Page 7-8

Conveyor idlers . . . detailed in booklet which has many photographs of installations. *Jeffrey Mfg. Co.*
Circle No. 737, Page 7-8

HANSBERG *Shooters*®

INCORPORATED
3212 CENTRAL STREET
EVANSTON, ILLINOIS, U. S. A.

P. O. BOX 729
CABLE ADDRESS "HANSHOOTER"

To the Foundrymen
of America

It is my great pleasure to announce the incorporation of Hansberg Shooters Inc. of America.

This new corporation will have its head office at Evanston, Illinois, and it has been my privilege to appoint Mr. William Geisler as President of this corporation in charge of all business carried on in America.

Those of you who have met Mr. Geisler, I believe, will agree with me in my wise selection of a man fully qualified to carry on these duties.

This new corporation, as of August 1, 1958, will assume all responsibilities for the sales, importation, manufacturing and servicing of all Hansberg Shooters in America.

The Hansberg Shooter line consists of 18 models including some CO_2 equipment, roll-over stripper and turntable model machines for core and molding production. This line will provide American foundries with the advanced proven method of making precision cores and molds more efficiently.

A complete inventory of Hansberg Shooters, all accessories, and replacement parts will be maintained at a Chicago warehouse. All Hansberg Shooters sold and installed in America, including those purchased in the past two years, will be serviced from our head office at Evanston, Illinois.

We are pleased to make this announcement which we believe will prove of vital importance to all American foundries.

Sincerely yours,

Fritz Hansberg
Chairman of the Board

Circle No. 837, Page 7-8

Circle No. 838, Page 7-8

Hook-on buckets . . . described and well illustrated with line drawings and photographs in 16-p booklet. *Erie Strayer Co.*
Circle No. 722, Page 7-8

Technical courses . . . information available. Designed to better educate plant and management personnel in industrial techniques, managerial problems, equipment operation, etc. *American Foundrymen's Society.*
Circle No. 723, Page 7-8

Lubricant pumps . . . air-motor operated, featured in catalog. Includes performance and selection charts, and design and engineering features. *Lincoln Engineering Co.*
Circle No. 724, Page 7-8

Shell molding . . . guide, 34-p booklet, covers all aspects of the process with photographs to illustrate operations. Revised edition. *Durez Plastics Div., Hooker Electrochemical Co.*
Circle No. 725, Page 7-8

free films

■ Motion pictures and other visual aids based on foundry processes and supplies are also yours *for the asking.* These films are suggested for formal or informal training groups. The owners of films in this column will send booking request forms to MODERN CASTINGS readers who circle the appropriate number on the Reader Service card (page 7-8).

Malleable Metals . . . 16 mm, sound, color, 13 min. Shows equipment and methods for high production of small castings. *Albion Malleable Iron Co.*
Circle No. 730, Page 7-8

Steel with a Thousand Qualities . . . 16 mm, sound, color, 37 min. Depicts manufacture of carbon and alloy-steel castings in a modern steel foundry. *Lebanon Steel Foundry.*
Circle No. 731, Page 7-8

American Engineer . . . 16 mm, color, sound, 29 min. Authentic, documentary and scenically beautiful report of the most inspiring and significant achievements of American engineers. *Jam Handy Organization.*
Circle No. 732, Page 7-8

Vacuum Melting of Alloys . . . color, 17 min, traces complete process of vacuum melting, beginning at the conference table where the melt content is discussed, and proceeding from test on to the finished product. *Utica Drop Forge & Tool Corp.*
Circle No. 733, Page 7-8

Offhand Grinding with Norton Abrasives . . . 16 mm, sound, color, 10 min. Shows operations of removing risers, gates and pads from steel castings, and other foundry grinding operations. *Norton Co.*
Circle No. 734, Page 7-8

Principles of Lubrication . . . 16 mm, black and white, 16 min. Film uses animation to explain why lubrication is necessary. *United World Films, Inc.*
Circle No. 735, Page 7-8

T&RI Offers Four Courses in September

Four AFS Training & Research Institute-sponsored courses will be presented during September. Three will be given for the first time, these are *Industrial Environment*, *Basic Engineering* and *Product Development*.

The fourth, *Metallography of Non-Ferrous Metals* is being repeated as the result of unusual interest shown in the first course.

Industrial Environment

T&RI Industrial Environment Course

Sept. 8-12 $65 Chicago

Send complete course outline and further details to:

Name ______________________

Title ______________________

Company ______________________

City ______________________

State ______________________

AFS Training & Research Institute
Golf & Wolf Roads,
Des Plaines, Ill.

A demonstration and lecture course on in-plant environment problems and safety. Appropriate for foremen, supervisors, engineers, safety men and top management. Subjects covered will be workmen's compensation, first aid, personnel protective equipment, physical examinations, occupational diseases, ventilation, radiation hazards and foundry noise. The course will be held Sept. 8-12 at the Hamilton Hotel, Chicago. Course fee is $65.

Non-Ferrous Metallography

T&RI Non-Ferrous Metallography Course

Sept 15-17 $40 Chicago

Send complete course outline and further details to:

Name ______________________

Title ______________________

Company ______________________

City ______________________

State ______________________

AFS Training & Research Institute
Golf & Wolf Roads,
Des Plaines, Ill.

A lecture course for melters, supervisors, foremen, foundry engineers, researchers, laboratory technicians, metallurgists and design engineers. Subjects will include history, basic metallurgy, terminology, equilibrium and phase diagrams, micro and macro analysis, physical properties based on metallographic interpretation, heat

FOUNDRY FACTS NOTEBOOK

NEW LIFE FOR OLD PALLETS

FOUNDRY FACTS NOTEBOOK *is designed to bring you practical down-to-earth information about a variety of basic foundry operations. As the name implies, this page is prepared for easy removal and insertion into a notebook for handy future reference.—Editor.*

The information contained in this article is reproduced in part from a technical pamphlet entitled "Care For Wooden Pallets Can Control Maintenance Costs To You," copyrighted in 1958 by the National Wooden Pallet Manfacturers Association. Copies of the pamphlet are available without charge by writing to the Association at 609 Barr Bldg., Washington 6, D. C.

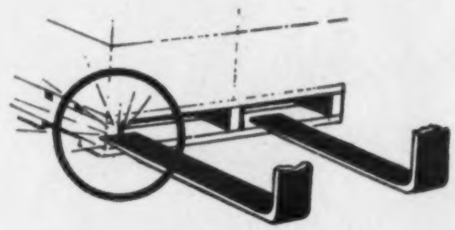


Fig. 2—If forks are spread too wide apart or not properly aligned when slid into position pallets will soon be splintered and broken.

Like any other type of materials handling equipment, wooden pallets give a maximum, trouble-free service life when not abused. If properly designed and constructed to perform under specific conditions, wooden pallets offer more real advantages to users than any other kind. A soundly constructed wooden pallet that is used properly without abuse will last indefinitely.

Since wooden pallets are economically and readily repairable, a reasonable maintenance program is not complicated and will pay for itself when put into practice.

Regardless of strength and durability any pallet can be broken or damaged by misuse or lift-truck accident. Some warehouse operations call for speed where abuse is unavoidable. Some companies find it undesirable or impossible to discipline fork truck operators. In such instances damage is to be expected, and maintenance is called for.

Neglect of pallets, after they are in use, can be a very costly practice. Since wooden pallets are economically and readily repairable, a reasonable maintenance program is not complicated and will pay for itself when put into practice.

This information is provided to show users how proper care and maintenance of wooden pallets can pay dividends and help protect pallet investment.

Don't Abuse

A pallet care and maintenance program should stress preventive measures as well as correct repair procedures.

Of importance to safe and efficient operations is the careful selection of individuals as operators of materials handling equipment. Persons selected should have the mental aptitude to enable them to understand and retain instructions. They should be instructed in operating procedures, warehousing methods, peculiarities of equipment, plant traffic regulations, and all safety rules for materials handling equipment.

First of all, users should be certain that their equipment is of proper design and construction for employment with the pallets which they have in their materials handling system. Most important in this respect is that the fork arms should preferably be as long as the depth of the pallet's fork entries, or not more than two inches shorter than such entries. This is for safety reasons, as well as to prevent damage to the pallets.

Fig. 1—Fork truck operator should be careful when sliding forks into place. Forks should be held level and spaced as far apart as possible for optimum distribution of load stresses.

Fig. 3—Line-up the truck with the pallet openings instead of pushing loaded pallets around with the fork.

NEW LIFE FOR OLD PALLETS

Fig. 4—Broken deckboards should be removed with care. Use either a pinchbar or a special thin chisel designed to cut off pallet nails.

Fig. 5—Arrows point to reinforcing stringers nailed on inside of original stringers damaged by rough use.

Handling Tips

Although some pallet damage is unavoidable, many pallets are damaged because of carelessness on the part of personnel engaged in pallet handling.

When engaging pallet, keep forks level; do not drag forks on the floor, nor enter or withdraw from pallet openings with tilted forks. (Note Fig. 1)

In entering or withdrawing from the pallet do not strike the stringer or blocks with the forks. (Note Fig. 2)

Do not slue the pallet around with one fork in order to line it up for the two fork entry. (Note Fig. 3)

When To Repair

Neglect of pallets after they are in use can be one of the most costly practices encountered in materials handling. On quick observation the decision when to repair and when to discard pallets may appear difficult, but upon analysis you will find it is relatively simple. By far the great majority of wooden pallet damages can be repaired economically, quickly and readily.

A rule of thumb to follow is to never repair a pallet that requires complete dismantling and reassembly of parts, or whose cost of repair exceeds the acquisition cost of a new pallet.

How To Repair

The following rules are suggested as a guide to correct repair procedures for wooden pallets in need of repair:

■ **Broken deckboards** are readily replaced when damaged. Such boards may be removed with a pinch or crowbar by wedging it beneath the broken part and exerting proper leverage. (Note Fig. 4) Boards should be loosened at one end, then the center, and finally the other end.

■ **Damaged stringers** in pallets may be repaired by abutting new stringers to those damaged. New stringers may be placed on either side of a damaged center stringer, and only one is necessary to repair this damage. When outside stringers are damaged, the new stringer should be abutted to the inside of the old one. (Note Fig. 5)

■ **In attaching new deckboards** be certain to shift the position of the board slightly, so that the new nailing does not hit nail parts left in the stringer or block, or does not enter the old nail hole. This is necessary to provide maximum nail holding power in repaired pallets. (Note Fig. 6)

■ **Purchase pre-cut deckboards,** blocks or stringers from your pallet supplier as this practice is more economical than the cutting of lumber into pallet parts by own personnel.

■ **Assign one person** the responsibility of deciding when to repair and when to replace pallets.

How To Protect

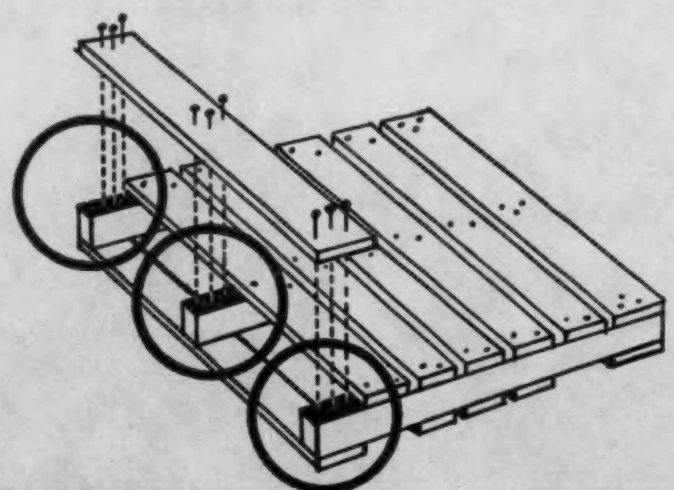
About 75 per cent of all pallet damage occurs in end deckboards. In nonreversible, double-face style pallets this damage occurs mainly in the two top edge deckboards, while in reversible, double-face pallets all four top and bottom edge deckboards account for this major damage.

Proper entry into fork openings on pallets can be facilitated by placing a leveling mark on the masts of all fork-lift trucks. This will indicate to the operator when the forks are parallel with the floor and thus are in safe position to enter or withdraw from the pallet openings.

The ends of stringers or blocks should be coated with paint or other compound in a bright color, such as orange or yellow, to facilitate the truck operator to quickly locate fork openings and the pallet in high stacks of warehoused goods.

When pallets are used outdoors where wide variations of moisture exist, it is highly recommended that they be treated with suitable combination wood preservatives and water repellents.

Fig. 6—Before nailing into position any new boards on a pallet it is recommended that old nails be clipped off with a cutter or driven in flush with a hammer. Shift position of new boards so nails don't enter old holes.



treatment, graphic representation. Equipment and basic principles of metallography will also be explained.

The course will be held Sept. 15-17 at the Hamilton Hotel, Chicago. Course fee is $40.

Industrial Engineering

T&RI Industrial Engineering Course

Sept 15-19 $125 Milwaukee

Send further details to:

Name ....

Title ....

Company ....

City ....

State ....

AFS Training & Research Institute
Golf & Wolf Roads,
Des Plaines, Ill.

Beginning motion and time study course introducing the foundryman to the basic principles of time study and work measurement for cost reduction. The why, wherefore and when of cost control in the foundry will be explained. How work standards are developed and how they are applied to foundry operations will be outlined. A basic course for industrial engineers, time study and supervisory personnel.

The course will be held Sept. 15-19 at the Marquette University Management Center, Milwaukee. Course fee is $125.

Product Development

T&RI Product Development Course

Sept. 24-26 Fee $40 Chicago

Send complete course outline and further details to:

Name ....

Title ....

Company ....

City ....

State ....

AFS Training & Research Institute
Golf & Wolf Roads,
Des Plaines, Ill.

Lecture course on product analysis from the design to the marketing of the finished casting. Study will be made of casting design, patterns employed, equipment, cleaning of castings, cost analysis, casting processes, engineering properties of cast metals, and sales promotion. Scheduled for all types of foundry engineers, sales engineers, technicians, supervisors, metallurgists and management.

The course will be held at the Sherman Hotel, Chicago, Sept. 24-26. Course fee is $40.

Attendance in each course is limited to insure constant and personalized instruction. All Institute courses include tests and personal progress reports to management.

the SHAPE of things

safety, hygiene, air pollution

It's Hard to Believe, But It's True!

Do you know that if you had a machine in the foundry causing a noise of 80 decibels and you installed another identical machine also causing a noise of 80 decibels, the resulting noise level would be only 83 decibels—not 160?

Facts like these are described in the new AFS FOUNDRY NOISE MANUAL now available. In reading through the book, I learned that an employee of the Federal Government may receive as much as $6300 for total loss of hearing in one ear, and $24,200 for both ears. In the various states, awards for loss of hearing due to injury range from a high of $12,333 in Wisconsin to a low of $1560 in Maine.

The book contains all sorts of other interesting and helpful information such as the following:

Nicotine (in tobacco), aspirin, quinine, etc., can cause hearing loss in susceptible people and continued use of these drugs may cause irreversible hearing loss. Many diseases such as mumps, measles, scarlet fever, diptheria etc., have been responsible for hearing loss in children. Thus industrial noise is only one of theagents that can cause hearing loss.

While you may not believe it, an electric furnace is just about as noisy as a shakeout; and air hoists are much noisier than is commonly believed.

If you wanted to enclose a noisy machine to prevent noise transmission, the manual shows that the one material not to use is sound absorbing material. "Sound absorbing material is like a blotter. The blotter soaks up ink but will allow it to pass right through". This kind of information may keep you from proceeding with expensive control measures that can only give disappointing results.

The chapter on "Engineering Control of Noise" describes all sorts of *practical* methods of controlling noise and gives noise-analysis curves to show how effective a particular control measure is. Sometimes the result obtained isn't worth the expenditure and knowledge of such limits enables the foundrymen to avoid expensive pitfalls.

In the chapter on "Personal Protective Equipment" I find that dry cotton used as ear plugs affords very little, if any, protection against noise; while commercially available ear plugs will effect an attenuation of noise as much as 35 decibels—and that's a lot.

Some persons have used swimmer's ear plugs for noise protection but tests show that these give relatively little protection since they are not designed for that purpose . . . neither are pencil erasers nor empty bullet cartridges.

Ear protectors, by cutting down the noise level reaching the ear, decrease distortion so that speech is actually heard more clearly, just as sun glasses, by reducing glare, improve vision.

After you read the chapter on "Physics of Noise" much of the mystery of noise and sound will vanish. You'll be surprised to find out that the ear can better tolerate noise of low frequency (low pitch) than that of high frequency. A wit once said that when Washington Irving wrote, "A tart temper mellows with age but a sharp tongue is the only instrument that grows keener with constant use," he was referring to the high-pitched female voice.

Training & Research Institute To Give 3-Day Course On Air Pollution Control and Legislation

Course Starts Oct. 1.

More and more, communities are enacting air pollution laws. Unless such laws are appropriate and reasonable, foundrymen will be forced to a lot of unnecessary expense to comply.

In offering this course, T&RI gives foundrymen an opportunity to understand the various types of air pollution ordinances and to evaluate the available control equipment for a given application.

The course is intended for management and engineers. Registrations are now being accepted by AFS, Golf & Wolf Rds., Des Plaines, Ill. Fee: $40.00; Place: Hamilton Hotel, Chicago.

Behavior of Foundry Sands in Production

by DR. F. HOFMANN
George Fischer Ltd.
Schaffhausen, Switzerland

The compactability of sands decreases with increasing grain size, resulting in lower green density of fine sands under identical ramming conditions. Permeability, however, increases with increasing grain size, being a function of medium pore width rather than of absolute porosity. Shatter index decreases, flowability increases with the increasing grain size.

Sands with well-rounded grains compact easier than sands with angular grains, but flowability is highest with subangular grains. Increase of sorting coefficient (grain size distribution) increases green density of sands due to higher degree of close-packing.

Silica sand expands far more with increasing temperature than any other molding material. This is the main reason for scabs. Heat expansion is considerably lower in sands containing feldspar. The much weaker and more linear expansion of zircon sand, chamotte and other molding material is by far more important than their refractoriness. The higher the alumina content, however, the higher the resistance against attack by molten iron oxide (shell castings).

In silica-sand cores completely surrounded by molten metal, silica expansion and metal shrinkage act simultaneously. Due to lower degree of compaction, fine sands can stand these opposing effects much better than coarse ones, thus reducing hot tearing.

Metal penetration is mainly a question of permeability: the finer the sand, the lesser the penetration tendency. High heat expansion (silica sands) opens the pores and favors penetration.

Scabbing tendency due to silica expansion is considerably reduced by addition of coal dust due to plastification of the sand at the critical temperature.

Furthermore, volatiles in coal dust produce a reducing atmosphere preventing the poured metal from oxidation and thus avoiding attack of molten-metal oxides and scorification of mold surface. Wood flour and pitch additions act the same way; while for magnesium castings sulphur and boric acid are used for the same purposes.

■ Abstracted from a talk presented at "Symposium on Recent Developments in Foundry Technology," Jamshedpur, India.

THESE
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ARE AT YOUR SERVICE

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Birmingham, Ala.

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Los Angeles 58, Calif.

Pacific Graphite Co.,
2522 Malt Avenue
Los Angeles, Calif.

Pacific Graphite Co.,
40th & Linden Streets
Oakland, California

Snow & Galgiani
533 Second Street
San Francisco, Calif.

Barker Fdry. Sply. Co.
120 S. Linden Avenue
S. San Francisco, Calif.

COLORADO
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Denver, Colorado

ILLINOIS
Hill & Griffith Co.
4606 West 16 Street
Chicago 50, Ill.

Foremost Fdry. Supply Co.
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Circle No. 839, Page 7-8

here's how

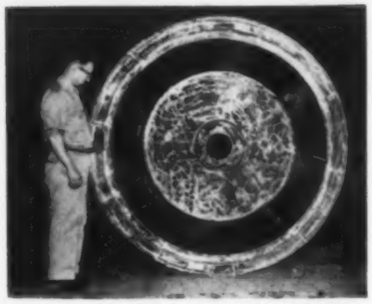
. . . the largest precision-cast tire mold looks as a picture frame for an average-size secretary at the Median, N.Y. plant of **American Brake Shoe**

Co.'s Engineered Castings Division. The 10,000-lb iron tire-mold half is used for producing tires with diameter of eight feet.

. . . ductile iron is used by **Warner & Swasey Co.,** Cleveland, for component parts of turrent lathes and other machine tools. The machinability of ductile iron is said to be a reason for Warner & Swasey using 275 turret lathe parts cast in 60-45-10

ductile. Over-all cost of finished components is said to be reduced as much as 60 per cent; and 20 to 25 per cent reduction is said to be common.

. . . **Chambersburg Engineering Corp.** produced guide-vane casting for Foster Wheeler Corp. water pump; 16,700 lb iron casting has 77 in. dia., is 84 in. high. Casting was poured in cement-bonded sand mold. To insure accuracy in dimension and angularity of vanes, the cement-



bonded sand was allowed to harden in the core box.

. . . **C. G. Conn, Ltd.,** makes music with die castings. The 24 keys on the Conn clarinet are now made as zinc-die castings, and the parts are said

to be more accurate and less costly than those produced by previous methods. A clarinet key is a complicated part, consisting of a body, one or more connecting rods, pad holder

and finger tab. The old method of production required castings, forging, and brazing together as many as seven pieces for some of the more intricate assemblies.

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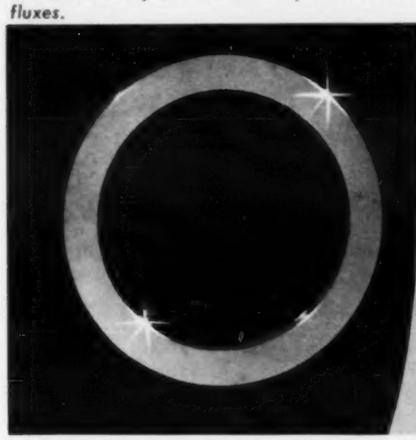

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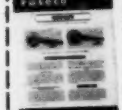

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Circle No. 840, Page 7-8

Mechanical Properties of Ferritic Nodular Cast Irons

by G. N. J. Gilbert
The British Cast Iron Research Association
Birmingham, U.K.

It has been shown that elongation in the tensile test is no criterion of ductility, since under impact conditions a material with a high-tensile elongation may be brittle. For components which may be subject to shock, loading the temperature of the ductile to brittle transition temperature in the impact test is the best criterion of ductility. This should occur at a temperature below normal in order to ensure that the component does not fail in a brittle way.

Silicon, manganese and phosphorus, and to a lesser extent nickel, all raise the tensile proof stress of ductile iron. They also raise the ductile to brittle transition temperature. Therefore the specification of a relatively high proof stress is not conclusive to obtaining the best ductility in the impact test.

In the annealing of ferritic nodular iron it is essential to use a two-stage annealing treatment involving heating in the austenite range to homogenize, followed by a sub-critical anneal to eliminate pearlite. A single-stage anneal at a temperature just below the critical stage results in a sub-boundary structure present in the ferrite. This structure is associated with poor impact properties.

The ferrite grain size of nodular iron can be reduced by decreasing the temperature at which austenization occurs during annealing. If a specimen is austenized at a temperature just above the critical range for sufficient time to obtain homogenization, a very fine grain structure may be obtained. A fine grain material has a much higher proof stress and improved ductility in the impact test.

Abstracted from a talk presented at "Symposium on Recent Developments in Foundry Technology," Jamshedpur, India.

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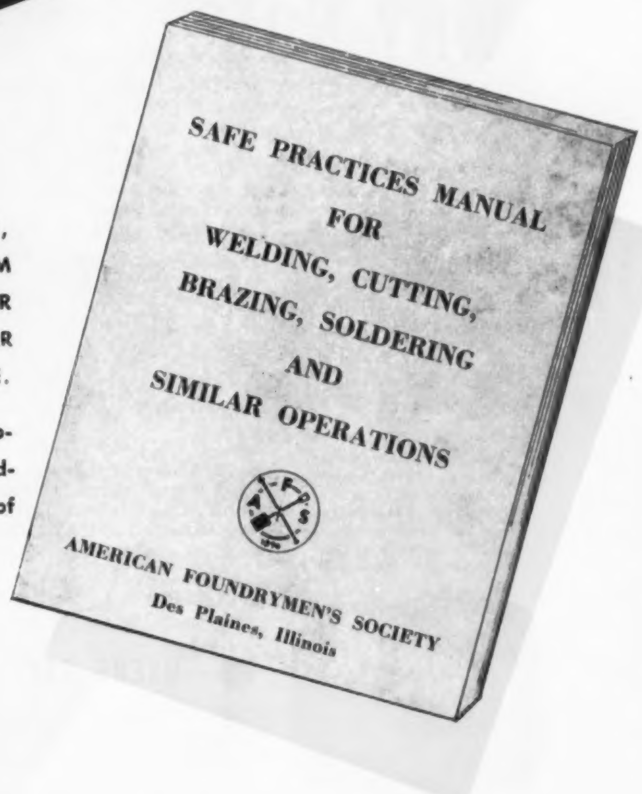

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questions and answers

Misery loves company so why not share your castings problems with us? MODERN CASTINGS invites you to "stump the experts" with tales of gremlins that are haunting your scrap piles. If any of you readers have better answers to the questions below, write the editor.

Q—We have recently installed a centrifugal casting machine for making iron cylinder liners. Our biggest problem seems to be getting hard iron on the surface of the liners, making it extremely difficult to turn them on a lathe. How can we get a soft as-cast surface?—J.J.S.

A—In pouring gray iron against a permanent mold one can usually expect a white iron skin to form as result of the chilling action of metal mold. Even with a high silicon iron it is hard to eliminate this bane of lathe operators. A refractory wash on the mold will often eliminate this condition. One foundry directs a stream of powdered ferrosilicon immediately ahead of the molten metal stream. This innovation serves a dual purpose—it insulates the molten metal from metal mold and softens the iron by reason of its innoculating effect.

Q—Nowadays you hear a lot about running a cupola acid, basic, or neutral. Please explain the meaning of these terms in simple three-letter words, is possible.—S.O.S.

A—The terms acid, basic, and neutral refer to the chemistry of the slag being formed in the cupola. Cupola slag is made up of several metal oxides. Calcium oxide, magnesium oxide, silicon oxide and aluminum oxide are the most important. The first two are basic oxides and the latter two are acid oxides. A chemical analysis of the slag will tell you the weight per cent of each oxide present in the slag. Add the per cent of calcium and magnesium oxides together and you have the total basic oxides present in the slag. The sum of the silicon and aluminum oxides gives the total acid constituents. Now divide the total basic oxides by the total acid oxides. If the answer is 1.0 then you are operating a neutral cupola; if less than 1.0 the slag is acid; if greater than 1.0, slag is basic. Does that clarify things a bit?

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and

determine what factors affect pressure tightness in copper-base alloys

MELT QUALITY AND PRESSURE TIGHTNESS OF COPPER-BASE ALLOYS

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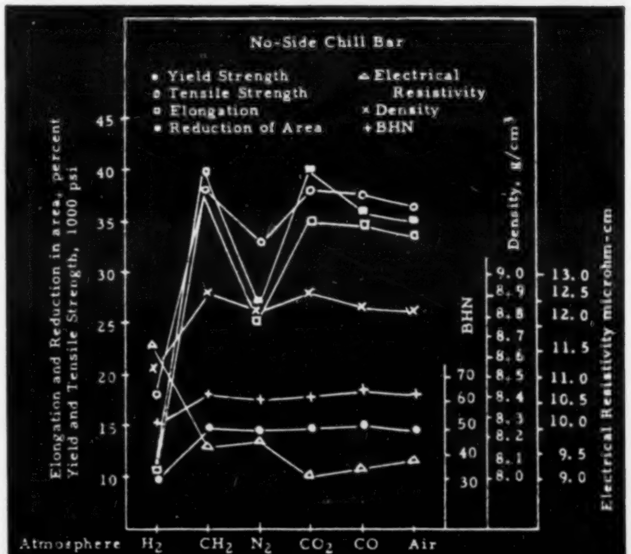

Fig. 7 - Effect of atmosphere during melting of 85-5-5-5 bronze on its properties (28) (No interpolation can be made between points.)

21 pp. 8 x 11 Paper Bound 10 Illustrations-Bibliography

AFS Members $1.00 *Non-Members $1.50*

Sponsored at Battelle Memorial Institute under supervision of the AFS Brass and Bronze Division's Research Committee, this survey traces factors affecting melting quality and pressure tightness of copper-base alloys, especially red brass. Causes of unsoundness and methods available to avoid gassing are concisely covered. Suggestions on how to obtain high quality and pressure tight castings are included, as is a list summarizing recommended good foundry practice. This booklet is an invaluable reference for foundrymen and metallurgists engaged in the production of copper-base alloys castings.

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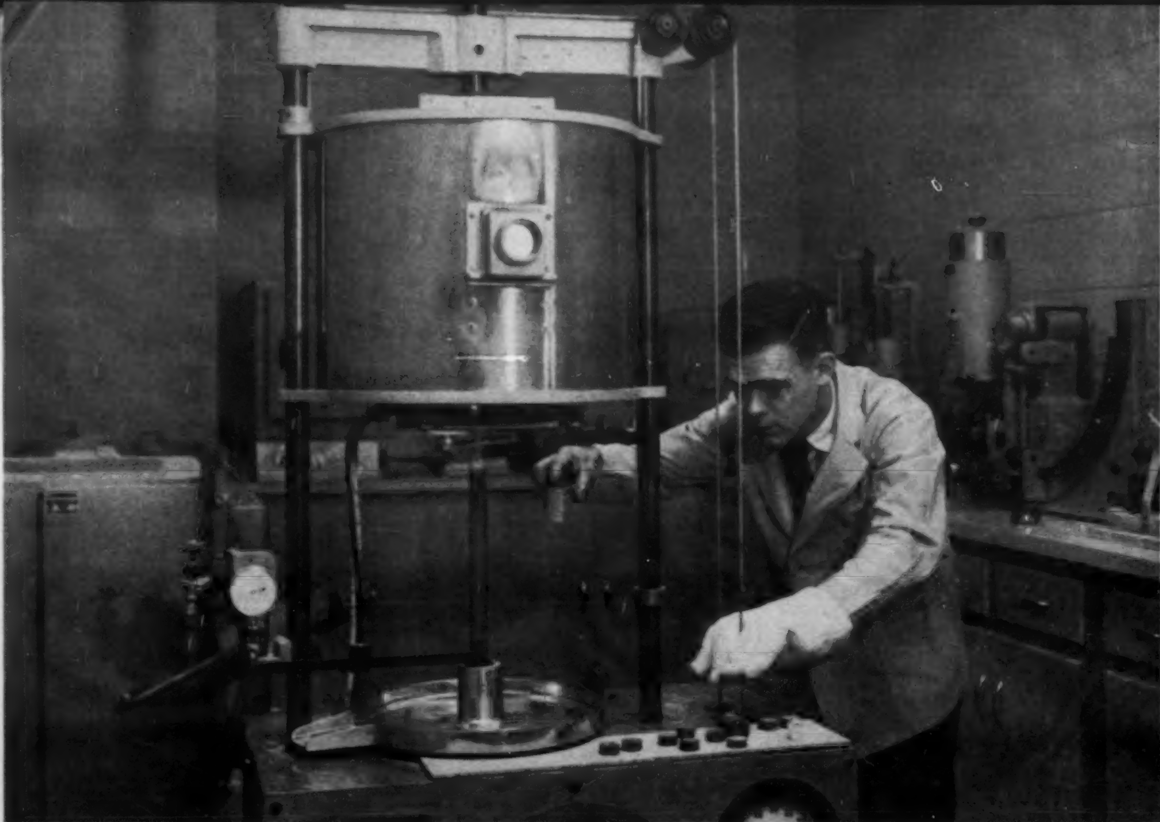

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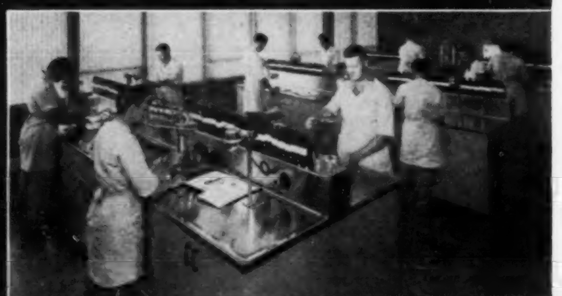

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Circle No. 843, Page 7-8

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GIFS Holds 30th Meeting

The 30th Annual Meeting of the Gray Iron Founders' Society will be held in the Nation's Capital during the three day period of October 8-10. Following past custom the program at the Sheraton-Park Hotel has been built around suggestions made by members of the Society. Interests of the gray iron industry are reflected in the program which has heavy emphasis on economics, labor relations, and competition from aluminum. The tentative program follows.

October 8

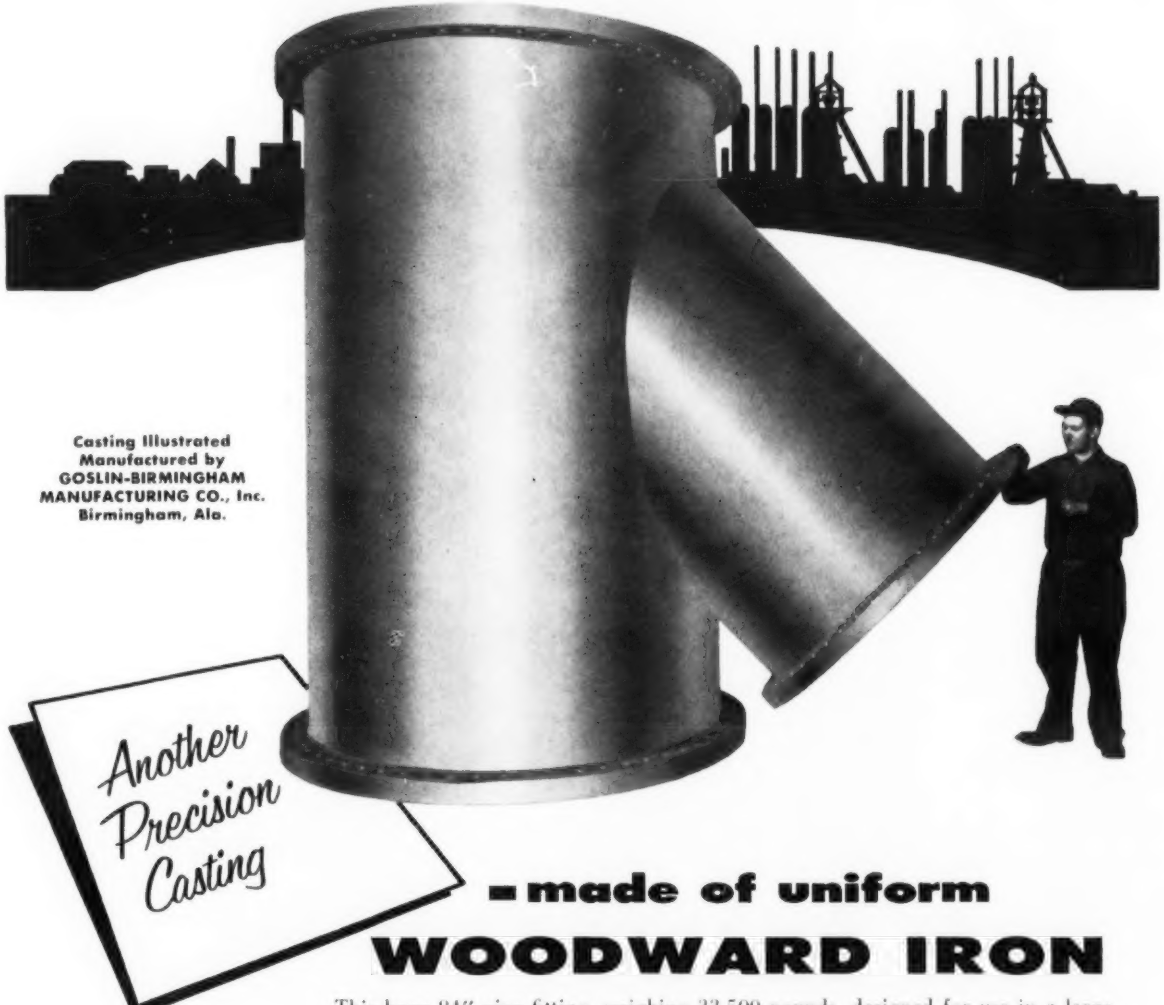
6:30 pm–President's Reception

October 9

9:30 am–Annual Business Meeting
Reports of Officers
Committee Reports
12 noon–Industry Luncheon
2:00 pm–Panel session–"An Economic Evaluation of Melting Equipment."
3:30 pm–"Implications of the Aluminum Automobile Engine."
6:30 pm–Reception and Banquet

October 10

9:30 am–
Horace B. McCoy, Administrator, Business & Defense Services Administration–"Helping Business is Our Business."
Anthony Alfino, Assistant Manager, Labor Relations & Legal Dept., Chamber of Commerce of the U.S. –"Dealing with Union Power."
Walter A. Slowinski, Attorney, Baker, McKenzie & Hightower–"Problems in Perpetuating the Closely Held Company."
12:30 pm–Industry Luncheon
Speaker: Fletcher Knebel, *Look* Magazine, and author of syndicated "Potomac Fever."
Presentations of new Officers and Directors
Presentations of 1958 Design Contest Winners
Presentations of Awards and Citations



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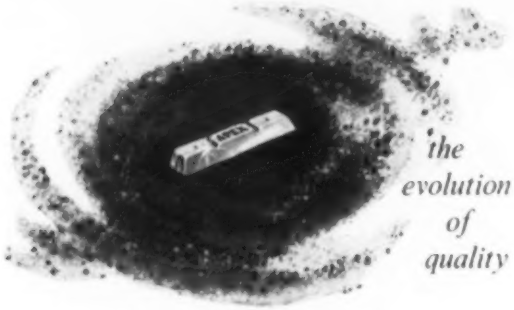

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